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Audio Scoring, Dubbing and Transfer Techniques Used in Video-Tape Productions

By JOHN D. SILVA

Many video-tape productions require post-production addition of music and sound effects to the original dialogue. Various methods have been used to accomplish this. Three methods have been used successfully at Station KTLA. Method 3, developed at Ryder Sound Services, Inc., is designed to achieve maximum control and is used to accomplish intricate mixing, scoring and dubbing operations. A variation of this method, devised for less stringent requirements, is used to avoid editing of sprocketed film. A proposed method, based on the use of a multichannel audio-tape recorder using 2-in. tape, is also discussed.

Introduction

Today's video-tape productions are usually concerned with three general types of audio program material: dialogue, music and sound effects. Producers and musical directors have long recognized that for maximum psycological effect precise control of the relative timing of these three pieces of program material is essential. Borrowing a page from the movie industry's book, TV producers have adopted the procedure of recording only the dialogue during the actual production shooting. Later, post-production mixing and scoring sessions are held, in which music and sound effects (including laughter, applause, narration, etc.) are added to the original dialogue in proper sequence on a final (composite) track.

In order to accomplish this, several methods have been devised in which music and sound effects are placed, separately or simultaneously, onto a composite audio track along with the dialogue. Of these methods, the following have been used successfully at KTLA:

(1) two video-tape machines recording from one to another via dubbing console (Fig. 1),

(2) three video-tape machines containing dialogue, music and sound effects obtained as shown in Fig. 1, recording on the fourth video-tape machine (Fig. 2) and

(3) one video-tape machine having its sound handling done on ¼-in. audio tape and sound film. A ¼-in. audio-tape composite track is finally transferred to the original soundtrack of the edited video-tape master (Fig. 3, 4, 5 and 6).

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Method 1

When Method 1 is used, a sync leader running approximately three minutes, is added to the front end of the master tape. The leader consists of some form of short audio beeps along with either oral or visual identification. Two dubs (copies or direct transfers) of the master tape (including sync leader) are made and the original is put aside. Machine 1 gets an audio feed from the output of a mixing console. The audio output of machine 2 is then fed to one of the inputs of the mixing console and to the sound effects and music sections via speakers or headphones.

Monitors are also set up showing the video output of machine 2. Machines 1 and 2 then play back the dubs, and are synchronized with each other through the use of their sync leaders. This operation must take place during the first three minutes of tape. Before the sync leader has run out, machine 1 is switched to its "audio only" record mode. Using the picture and audio material from machine 2 as reference, the sound effects and music are simultaneously mixed with dialogue in the scoring and dubbing console, which in turn feeds machine 1. The two additional pieces of audio material are now recorded along with the dialogue in synchronism with the original audio dialogue as played back on machine 2.

This procedure may be carried out in one entire operation or may be broken down into two- or three-minute segments, as required by the musical director handling the musical scoring. In the latter case the machines must be stopped after each segment. A one- or two-minute adjacent section of previously recorded material is then used as sync leader for each succeeding segment. When this procedure has been completed, the composite audio track is then checked for accuracy and also to determine if the desired effect has been accomplished.

The next step is to transfer this composite audio track to the original master containing only dialogue. This is done by synchronizing the dub containing the composite audio track and the master together at the front end, and recording the dub's audio onto the master through the use of the "audio only" feature of the video-tape equipment. It should be noted that laughter and applause are classified as sound effects and handled as such. When post-production narration is required, it is usually handled simultaneously with music and sound effects. If this is not possible, the composite track containing dialogue, music and sound effects is not transferred to the master, but instead is held until narration can be recorded. A final composite track consisting of dialogue, music, sound effects and narration is then made, using the same techniques described above, with the addition of one generation of audio.

Method 2

Method 2 is an extension of Method 1. Production and audio personnel have found that greater control can be obtained by having music and sound effects recorded separately. This method produces three separate tracks which later are added together in synchronism as a composite track. The operation is as follows:

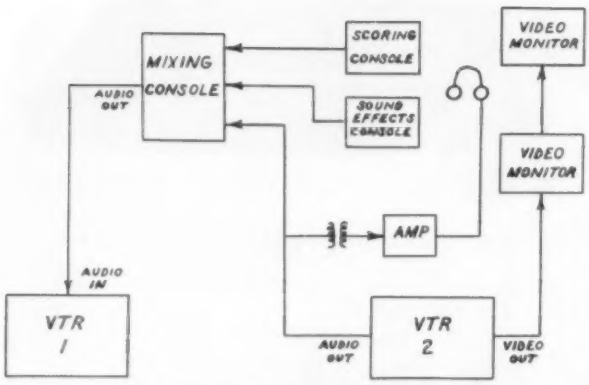

Fig. 1. Equipment setup for obtaining one composite audio track from three separate sources.

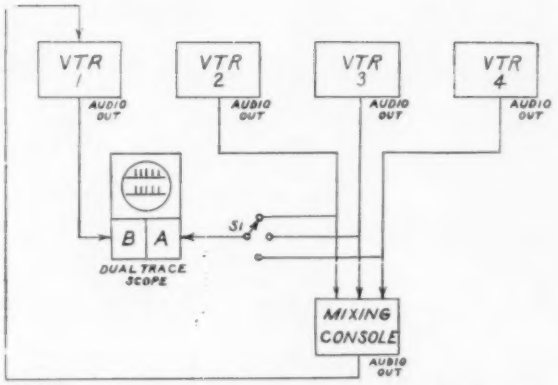

Fig. 2. Equipment arrangement for synchronizing three separate audio tracks on individual video tapes for transfer to the master video tape as a composite audio track.

Five minutes of sync leader is added to the master tape. From the master, four dubs are made. If possible, these are made simultaneously in order to prevent wear on the master. One dub is placed on machine 1 and a second on machine 2. The audio output of machine 2 is connected to headphones or speakers for the musical director and audio personnel involved. The picture output is connected to video monitors in the dubbing room. The audio mixing console output is fed to the audio input of machine 1. The input of this audio console is fed with either music (live orchestra or recorded material) or sound effects. Machines 1 and 2 are placed in their "playback" modes and are synchronized at the front end. When this has been accomplished and before the sync leader has run out, machine 1 is switched to its "audio only" record mode. The music or sound effects is then recorded in synchronism (through the use of speakers or headphones and the accompanying monitor for machine 2). The result on the video tape on machine 1 is a separate track (sound effects or music), which has the desired time sequence.

A second session handling the remaining audio material completes a complement of three separate audio tracks, each on a separate video tape having identical picture references. It is then necessary to make one composite audio track from these three separate tapes. Four video-tape machines are now involved. The fourth dub is placed on machine 1 and the three other dubs containing individual dialogue, music and sound effects are placed on machines 2, 3 and 4. All video-tape machines are connected so that they may be simultaneously started or stopped. The audio outputs of machines 2, 3 and 4 are brought to separate contacts on a three-position switch, the swinger of which is connected to one input of a dual-trace oscilloscope. The audio output of machine 1 is fed directly to the second input of the dual-trace oscilloscope. The audio outputs of machines 2, 3 and 4 are simultaneously fed to separate inputs of a mixing console, the output of which is connected to the audio input of machine 1. All machines are simultaneously started and placed in their playback modes.

The next step is that of synchronizing accurately these four machines. Utilizing the dual-trace oscilloscope, the beeps on the sync leader of machine 1 are

Fig. 3. Complete edge number and resolver system equipment: left, 16mm edge number equipment; center, Resolver and Re-Synchronizer; right, ¼-in. audio-tape equipment.

Fig. 4. The Resolver handle used in advancing or retarding ¼-in. audio tape.

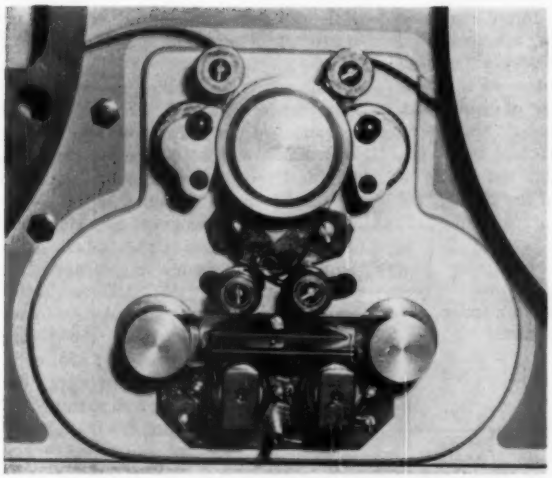

Fig. 5. 16mm magnetic film playback equipment for aural edge numbers. Staggered heads at bottom: left, video-tape recorder and ¼-in. audio-tape edge numbers; right, 35mm kine edge numbers.

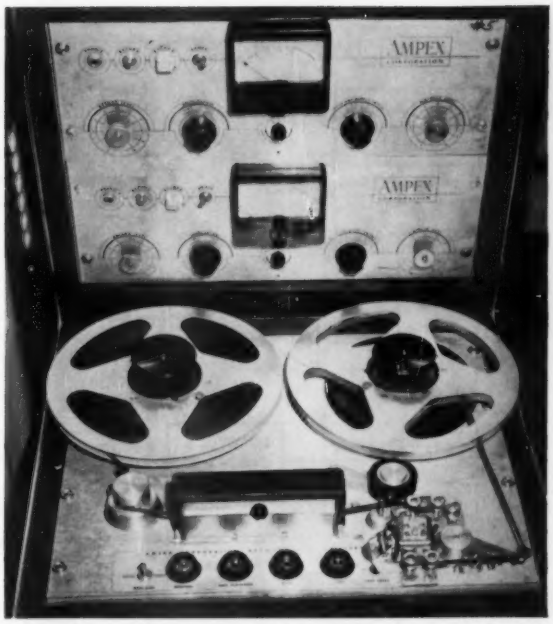

Fig. 6. ¼-in. audio-tape equipment with edge control track facilities.

compared with those on machine 2 which is retarded or advanced to match exactly machine 1. Machine 3 is then synchronized in the same manner to machine 1, and finally, machine 4 is brought into exact unison with machine 1. All of this must take place on the five minutes of sync leader at the front end of these tapes.

Machine 1 (containing the fourth dub) is then switched to its "audio only" record mode, and the three separate audio tracks, properly mixed, are recorded as a composite audio track. The tape from machine 1 is checked to determine if the desired result has been accomplished. If the tape is approved, the composite soundtrack is transferred to the master tape in the manner described above.

At present there is a difference of opinion as to which of these two methods is superior. From a control standpoint Method 2 is the more advantageous; but this method is generally used only in the early morning hours after a station has signed off. Usually, the efficiency of a crew, not normally scheduled for early morning duty, reaches a low ebb at the time that efficiency is most urgently needed. Consequently, the extra control available is lost in a maze of grogginess. Method 1, involving only two machines, can usually be scheduled for daylight or early evening hours when efficiencies are at a higher level.

Method 3

To avoid resorting to compromise when maximum control is desired, two additional methods (one a simplified version of the other) have been developed. A system using film sound handling techniques was originated by Loren L. Ryder, President of Ryder Sound Services, Inc. Mr. Ryder developed and built the prototype equipment for this system in cooperation with Television Station KTLA early in 1960. This system involves the use of (1) ¼-in. audio-tape equipment running 15 in./sec, providing a special edge-recorded control track; (2) 35mm film-recording equipment with an optical soundtrack; (3) 16mm magnetic film playback equipment having a synchronous motor and laterally staggered audio heads for subsequent recording of audio edge numbers; and (4) special resolving equipment allowing precise advancement or retardation of the ¼-in. audio tape during playback. This equipment is presently in use at Station KTLA and has been successfully employed on many large-scale productions for intricate mixing, scoring and dubbing.

Recording Phase of Method 3

In this system the show is handled on video tape in the normal manner with only dialogue recorded on the audio track. Successive takes (not necessarily in sequence) are generally grouped together on one reel during the course of a day's shooting. At some convenient time (preferably immediately following the day's shooting) the master video tape is played back and checked for overall quality, and at the same time the video information from the video-tape master is fed to the equipment for television recording on 35mm film. The audio from the video-tape master soundtrack is recorded on the program (center) track of the ¼-in. audio tape (Figs. 7 and 8). As this audio track is laid down, a 60-cycle control signal is also recorded on both edges of the ¼-in. audio tape by a special split echelon head (developed by Ryder Sound Services); this sound is simultaneously recorded on 35mm sound film. (This film is commonly used in motion-picture work and consists of a continuous magnetic stripe, or track, placed on blank 35mm film stock.) During this operation, corresponding audio edge numbers are recorded on (1) the optical audio track of the 35mm film on which the picture is being recorded; (2) the cue track of the video-tape master; and (3) the edge tracks of the ¼-in. audio tape. These aural edge numbers are obtained by playing back a 16mm sprocketed magnetic film on which there has been previously recorded one hour of progressing edge numbers spaced at one-second intervals.

The edge number material is similar to that originally developed by NBC, Hollywood. It consists of 1900-cycle beeps every second for a period of slightly over one hour. Immediately following each even-numbered beep, a man's voice identifies the video-tape reel (A, B, C, etc.) and the minute of the hour following the start of the film. Immediately following each odd-numbered beep a woman's voice identifies the seconds of the minute (1 through 59). For example, the tape might start in the following manner: *BEEP*, (Man's voice) "A — Zero," *BEEP*, (Woman's voice) "1," *BEEP*, (Man's voice) "A — Zero," *BEEP*, (Woman's voice) "3," *BEEP*, (Man's voice) "A — Zero," *BEEP*, (Woman's voice) "5," etc.

In order to maintain editorial sync between all three recordings, the edge numbers are played back from two

separate heads on the 16mm magnetic film equipment which are displaced laterally from each other by an amount exactly equal to the difference of sound "pull-up" in each piece of equipment. On video tape the sound and cuing information leads the picture by 9¼ in., whereas on 35mm film the audio is 20 frames in advance of the picture, the difference being 20/24 less 9.25/15 or 0.216 sec (1.555 in. for 16mm film) (Fig. 8).

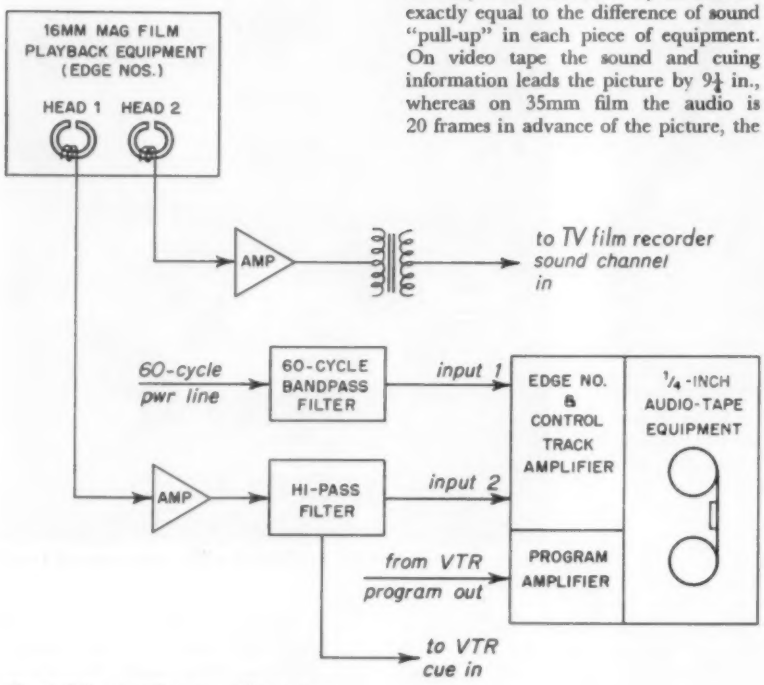

Fig. 7. Edge number recording setup.

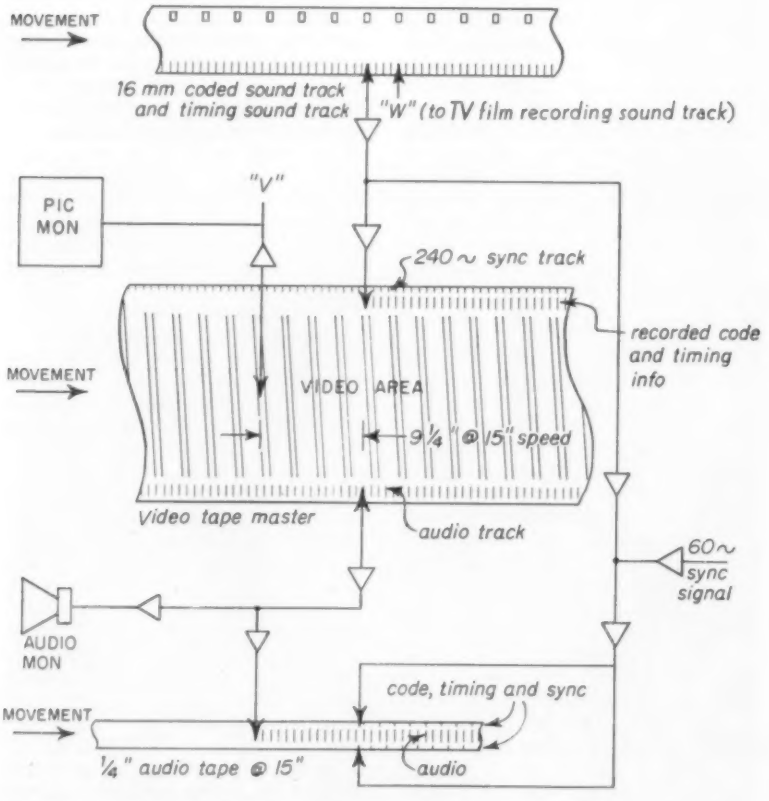

Fig. 8. Schematic of transfer setup.

The video tape then has aural edge numbers on its cue track 9¼ in. in advance of its corresponding picture information. The ¼-in. audio tape has identical edge numbers on its edge tracks 9¼ in. in advance of its corresponding audio program material. The 35mm film also has edge numbers on its audio track 20 frames in advance of its corresponding picture. These latter numbers are advanced numbers derived from the leading head on the 16mm edge-number track which is 1.555 in. in advance of the head, providing the edge numbers to the video tape and ¼-in. audio tape. Again, this is necessary to allow for "pull-up" differences.

Editing the 35mm Film

The 35mm film and the corresponding dialogue on the 35mm sound film is edited on equipment such as a Moviola. Later, the video-tape master is edited to match the editing of the 35mm film. An optical 35mm film reader and special video-tape readers for the cue and program tracks are used for this editing. A distance measurement is made between each splice and its corresponding preceding edge number for the 35mm film containing the picture information. The corresponding splices on the video-tape master are then determined by locating respective edge numbers and laying out corresponding distance measurements on the video tape. Because of the different speeds of the two medias (75 ft/min for videotape and 90 ft/min for 35mm film) the video-tape measurements must be calculated by multiplying the 35mm distances by $\frac{5}{6}$. This is done rapidly by using a chart or rule having a 5 to 6 proportional scale.

When the edited video-tape master is played back it will be noticed that frequently the audio has lost conformity at the splices. This happens because the sound is 9¼ in. in advance of the picture on the video-tape master. It is of no consequence, however, because the finished audio track will be derived from the previously edited 35mm sound film which matches the edited video-tape picture.

The next step is to take care of any requirement involving musical scoring or sound effects, or both. If the musical scoring is to be accomplished by a live orchestra, the 35mm film containing picture information and the dialogue track on the 35mm sound film is used by the musical director for rehearsal and timing. Using the same two sources, the scoring is eventually accomplished and the resultant audio recorded on a second 35mm sound film in synchronism with the original dialogue.

If the musical scoring is done synthetically, the music editor, using a Moviola,

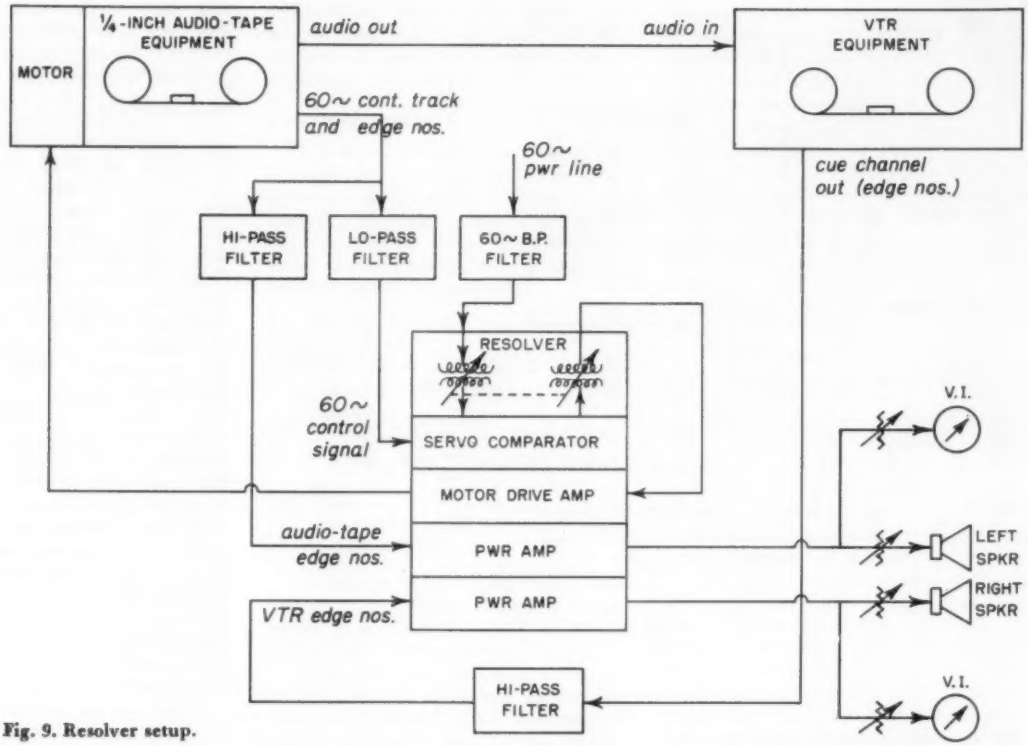

Fig. 9. Resolver setup.

will build his music track, piece by piece, in synchronism with the 35mm sound film dialogue track and 35mm recorded film. When the track has been completed he transfers it over to the second 35mm sound film in synchronism with the original dialogue.

Sound Effects

The sound-effects editor then goes to work. His operation is identical with that of the synthetic musical scoring procedure, except that he builds a sound-effects track, piece by piece, also by use of the Moviola. When this has been completed the built-up track is recorded on a third 35mm sound film in synchronism with the original dialogue and music track.

The three 35mm sound films and the 35mm TV-recorded film are then taken to the dubbing studio. Here the producer and editors listen to a mix of all three tracks in synchronism with the 35mm TV film. At this point they may decide to add certain special sound effects such as chicken noises, brush noises, wind, etc., which can be provided at the dubbing studio through the use of continuous magnetic film loops. Also, notation is made of any portions of the original dialogue that may have a change of level that must be manually corrected. In addition, the original dialogue may contain unwanted noises, such as a hiss. These noises may be eliminated experimentally by the use of high-pass, low-pass or notch filters. When all this has been done and everyone is satisfied with the sound mixture, the program material is re-run, mixed, and recorded as a composite audio track on ¼-in. audio tape. During this operation the audio tape is run on the same equipment as that described above, or on similar equipment, used to lay down a 60-cycle control track on the edge of the ¼-in. tape. Simultaneously the edge number track of the 35mm recorded film is re-recorded in synchronism on the edge of the ¼-in. audio tape along with its control track. In other words, the aural edge numbers and the 60-cycle control track are superimposed on the edges of the ¼-in. audio tape.

Finally, the composite audio track is transferred to the audio track of the edited video-tape master. This is done by the use of (1) the ¼-in. audio-tape equipment; (2) a special resolver unit which allows the advancing or retarding of the ¼-in. audio tape as it passes through the machine; and (3) a Re-Synchronizer unit which allows an aural and visual measurement of the time difference between the sound and picture by comparison of audio edge numbers on each tape.

A two-minute portion of sync leader is attached to the front end of the original video-tape master before the transfer to film and edge number recordings are made. This sync leader is retained throughout the video-tape editing and sound handling procedures for the synchronizing of the final ¼-in. composite audio track with the original video-tape master on this final transfer.

Equipment for Method 3

The equipment arrangement for this process is shown in Fig. 9. The 60-cycle control signal and aural edge numbers from the ¼-in. audio tape are fed through high-pass and low-pass filters, respectively. The output of the low-pass filter results in a pure 60-cycle control signal which is fed as input 1 of a servo comparator unit. The output of the high-pass filter consists of pure edge numbers originally recorded on the ¼-in. audio tape. This output is fed into the input of a power amplifier, the output of which drives a speaker and companion volume indicator meter. The cue output of the video-tape machine handling the edited master is fed through a high-pass filter, the output of which contains the edge numbers originally recorded on the master. This signal is fed to the input of a second power amplifier which in turn drives a second speaker and companion volume indicator meter. These two speakers are used to measure aurally the relative time difference between the two edge numbers. Their respective volume indicator meters are added simply to augment this measurement, visually.

The reference signal (input 2) for the servo comparator unit is taken from the 60-cycle power source. It is first processed through a 60-cycle bandpass filter to eliminate unwanted harmonics, subharmonics and transients, then into a Resolver unit and finally to the servo comparator. The Resolver is, in fact, a servo transformer. The primary consists

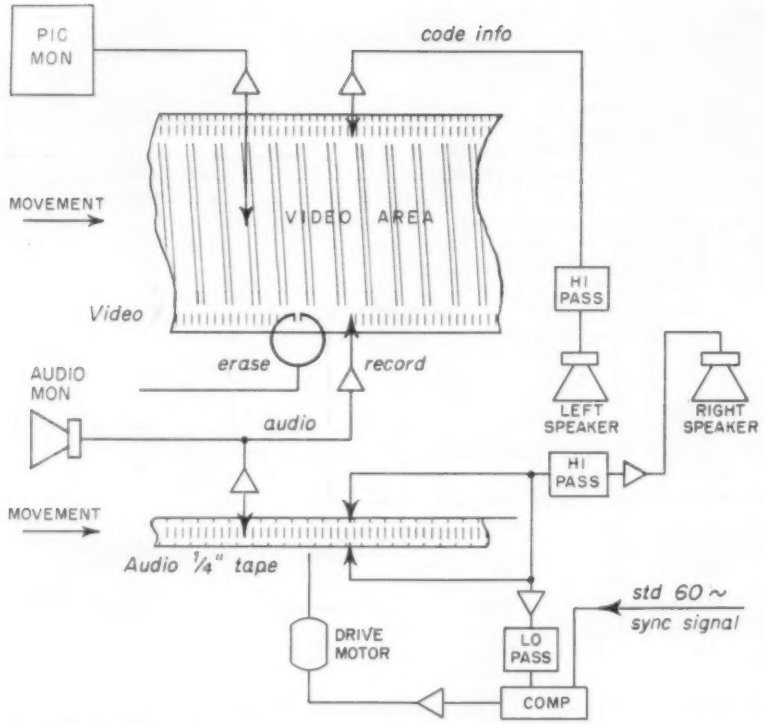

Fig. 10. Re-Synchronizer schematic.

of a stator winding and the secondary a rotor winding. The phase of the output signal is determined by the position of the rotor with respect to the stator winding. The output of the servo comparator unit is a nominal 60-cycle waveform derived from a comparison of its two input signals. This is fed through a second Resolver unit, the output of which is connected to the input of a third power amplifier. This unit is the motor drive amplifier for the ¼-in. audio-tape motor. This signal allows precise determination of the speed of the ¼-in. audio tape by means of the control track that was orginally recorded on the edge of the ¼-in. audio tape. The rotors of the two Resolver units are gang-coupled to a common rotary handle. The rotation of this handle allows for the advancing or retarding of the ¼-in. audio tape for synchronizing purposes. One complete revolution of this handle causes a shift of the ¼-in. tape by an amount equivalent to four television frames.

The process is completed when the program-track output of the ¼-in. audio-tape machine is fed directly to the audio input of the video-tape machine involved in the transfer (Fig. 10).

Step (1) in the procedure consists of cuing the ¼-in. audio tape to a specific edge number approximately 30 seconds in from the beginning of the sync leader. Step (2) consists of playing back the video-tape master at the beginning of its sync leader. The edge numbers from its cue track are heard on the speaker at the right on the Re-Synchronizer unit. When the same video-tape edge number as was previously cued up on the ¼-in. audio tape comes by, the ¼-in. audio-tape machine is started as close in sync as possible. The edge numbers of the latter tape are monitored on the speaker at the left. By watching the two meters and listening to the two speakers it is now possible by rotating the resolver handle to advance or retard the ¼-in. audio tape until the two audio tracks are in exact synchronism. This must be done while playing back on the two-minute sync leader. When this has been accomplished and before the sync leader has run out, the video-tape machine is placed in its "audio only" record mode, thus transferring the composite ¼-in. audio to the video-tape program track. For the remainder of the transfer it is necessary to monitor closely the two speakers for any differences that might occur in tape timing, and to adjust the Resolver accordingly. This is particularly important at splices because of the 5-frame/4-frame relationship between the television signal and the film. Because the video-tape master was edited exactly in accordance with the film, a cumulative timing error will result. This is easily compensated for by the use of the Resolver and Re-Synchronizer unit.

A question may arise as to the reason for the recording of the program sound on the original ¼-in audio tape during the recording of edge numbers. This recording is necessary, as it becomes the only record of the original uncut soundtrack, once the video-tape master has been edited in accordance with the previously edited TV film.

Method 3 (Alternative)

A variation of this system has been devised for use when it may be desired to avoid the editing of sprocketed film. This could be if either the sound-effects track or the music track, or both, were not required or if they were very simple. In such a situation the original video-tape dialogue would be transferred only to the ¼-in. audio tape and edge numbers would be recorded on the respective cue tracks of the video-tape master and the ¼-in. audio tape. The editing of a video-tape master would then be handled by conventional methods or by using the TVola (a device allowing frame-by-frame editing of video tape). The audio tape is then edited in accordance with the video-tape master by matching respective edge numbers by use of special sound readers for both the video tape and the ¼-in. audio tape. Post-production sound handling would then be performed by the use of ¼-in. audio tape having edge-recorded control tracks.

Finally in this proposed alternative, a ¼-in. composite audio track is made, and transferred to the audio track of the video-tape master by the Resolver method described above.

The advantages of this alternative system are that (1) it lends itself to simplified video-tape production and (2) it provides an effective double-system recording which eliminates the problem of the sound being 9½- in. in advance of the picture, thus allowing freedom of editing.

The disadvantages of the alternative system arising from the use of only the ¼-in. audio tape are two: (1) The musical director does not have the advantage of a television film recording for rehearsal and timing. A copy of the edited video-tape master must be made, which causes wear on the master and ties up expensive equipment required for rehearsals. (2) It involves the use of several ¼-in. audio-tape Resolver units when music and sound effects are required in the making of a composite audio track.

Proposed method

Another system for sound handling of video-tape productions where maximum control is desired has been proposed by Station KTLA. This method involves the utilization of a multichannel audio-tape recorder using 2-in. audio tape similar to that used in video-tape recording.

The proposal includes housing the equipment in a console similar to the Ampex VR1000B Videotape* Recorder.

* Trademark of Ampex Corp.

Used for recording program, cue and control track channels, the proposed equipment features facilities for recording up to eight separate tracks of additional audio information in synchronism with the original audio program track. During the recording process both video-tape and audio-tape capstans are controlled by the incoming sync. In the playback mode, the audio-tape capstan is driven by a 60-cycle signal derived from its previously recorded 240-cycle control track waveform and is corrected by the "difference" signal formed by the audio and video control track signals, as compared.

Both machines will operate during the original take with program sound, cue track and control track recorded on both machines simultaneously. This special equipment will incorporate three rows of in-line stacks each containing ten audio heads. The row on the left will consist of erase heads of the type normally found in audio-tape equipment. The middle row will contain ten in-line record/reproduce heads, one for the original audio track, eight for recording subsequent special audio material, and one for cue. All heads in this stack except the cue head are designed for maximum recording quality rather than playback. (It should be noted that an audio head designed especially for recording does not give the highest quality results during playback, and the reverse is also true.) The third row consists of a ten-head in-line stack of nine precision reproduce heads and one control-track record/reproduce head. The tenth head in this stack is a record-reproduce head for control track.

It is planned to house the record and playback amplifiers in an over-the-console mount accessible to the tape operator, with setting of gains and performing switching functions accommodated by finger-tip control. The inputs and outputs of these amplifiers may be mixed into any configuration, eliminating the need for the auxiliary sound console generally used in the process of transferring multiple tracks to a single composite track. The electronic assemblies are planned for standard Ampex Model No. 351 configuration, but with self-contained bias buffer amplifiers rather than the normal buffer oscillator circuit.

A Sel-Sync Control Panel will also be incorporated in the over-the-console mount to provide selective synchronization of the nine audio channels. Basically, the panel switches individual heads from the record to the playback mode, permitting all channels to be recorded separately in complete synchronism. The Sel-Sync reproduce function is used only for monitoring purposes during the process of recording a subsequent track in synchronism with a previous one. This feature, required for sound-on-sound recording, does not usually exist in conventional magnetic tape recording configurations.

Expected Performance

In general, program audio and cue channels are expected to exceed performance specifications for the corresponding channels in the earlier video-tape equipment. The eight auxiliary audio channels are expected to have the following specifications:

(*1*) *Frequency Responses:* −2 db from 50 cps to 15 kc.
(*2*) *Signal-to-Noise-Ratio:* 55 db at maximum operating level. (3% distortion)
(*3*) *Crosstalk Rejection:* 60 db or better between adjacent channels at 1 kc.
(*4*) *Flutter and Wow:* less than 0.15% rms measuring all components between 0 and 200 cps.

The equipment is so arranged that four additional auxiliary channels can be added, if required, to make possible a total of twelve subsequent recordings.

To illustrate how this equipment can be operated in connection with post-production audio additions, let us assume that a production has just been completed. Only dialogue has been recorded and the master has been edited. In addition, a dog, used in several scenes, had been required to bark. His trainer had given oral commands which must be removed from the dialogue track. Sound effects and live orchestra scoring are required and a vocalist, who cannot meet the muscial scoring date, is contracted for.

During the taping of the show, dialogue is recorded on the audio tracks of the video-tape masters and on the program track of the multitrack audio-tape machine. At the same time, audio edge marks are recorded simultaneously on the master video tape and multichannel audio cue tracks. When the master is edited, the 2-in. audio tape is also edited to match the master tape by the use of identical edge marks.

Later, the sound-effects dubbing session is held. The sound-effects engineer (through the use of a video monitor fed from the video-tape machine playing back a dub of the master and headphones monitoring the program track of the multichannel audio-tape machine) inserts the necessary sound effects through his mixing console to auxiliary track No. 1 on the multichannel audio-tape machine. Because the sound-effects man monitors the original dialogue and records material on heads of the same in-line stack, exact time synchronism of the two tracks is achieved.

A musical scoring session is scheduled and after rehearsal for musical cues, the orchestra is mixed in the audio console, the output of which is fed to and recorded on auxiliary track No. 2 of the multichannel audio-tape machine. In this instance, the muscial director obtains his cues on earphones from the program channel and auxiliary channel No. 1 tracks, in line with the audio head on which the music track is being recorded.

There are now three separate synchronized tracks (dialogue, music and sound effects), all first generation audio material. It then becomes necessary to eliminate the oral commands given to the dog, required to bark in the original shooting. In order to make this possible the production can be so arranged that the commands would be given at instants where dialogue did not occur. The program track is replayed; at the proper intervals (oral commands), the channel is placed in its record mode. No audio is fed to the input of this channel, consequently direct erasure is accomplished.

On the contract date, the vocalist arrives for a vocal scoring session. The music from auxiliary track No. 3 on the multichannel audio-tape machine is monitored by her on a pair of headphones in a sound studio. The output of the mixing console involved is fed to and recorded on auxiliary track No. 4, again exactly in line with the head reproducing the musical score.

All individual components are now complete and in exact synchronism. The outputs of all tracks are then internally mixed in the multichannel audio-tape machine and are monitored to check for accuracy and effectiveness. When the work has been accepted, the multitrack audio tape and the original master tape are synchronized by the use of sync leader at the front end; and the four audio tracks are again mixed and transferred over to the audio track of the master. The process is now complete.

The above procedure is a double-system recording technique providing two additional advantages: (1) one less generation of sound on the finished master; and (2) complete editing freedom without interferring with the program sound, which is recorded $9\frac{1}{4}$ in. in advance of the video information on the video tape.

Acknowledgment

The author wishes to thank Ampex Corp. of Redwood City, Calif., for supplying the engineering specifications on the proposed multitrack audio-tape equipment.

Also, special acknowledgment is due Loren L. Ryder and the firm of Ryder Sound Services, Inc. Mr. Ryder first discussed the Resolver method of sound handling with the author early in 1960 and then undertook development of the equipment required for the system now in use at KTLA.

Improved Synchronizing System Using Magnetic Tape

By LOREN L. RYDER

A new method has been devised for synchronizing cameras and sound recorders. Equipment which has been designed and developed specifically to meet the requirements of this new system includes sync generators for cameras; echelon synchronizing heads for ¼-in. tape recorders; and Re-Synchronizers for dual-film projection on ¼-in. tape. The method is applicable to 35mm, 16mm and 8mm photography. Its adaptability suggests the expansion of its use to the amateur field as well as to industrial and educational fields.

THE METHOD DESCRIBED enables anyone who has a motion-picture camera of any manufacture, a ¼-in. tape recorder of any manufacture and a projector of any manufacture to shoot and project synchronous sound motion pictures. It is an overall system with many possibilities and applicable to 35mm, 16mm and 8mm photography. It is being used by Hollywood major studio theatrical and television producers and producers of commercial, industrial, educational and religious films. This system is now being expanded to the amateur field.

In this method a synchronous generator or transformer associated with the camera drive creates a synchronizing signal that is recorded on the edges of audio ¼-in. tape. This provides an index between picture and sound. During reproduction the synchronizing signal controls the relative position of the sprocket-driven film with respect to the tape, thus effecting synchronization.

This method is quite different from all previous systems. Sync generators are provided for spring-wound and d-c motor driven cameras. The synchronizing signal for synchronously driven cameras is obtained by a voltage reduction from the power source in a manner similar to previous systems. The synchronizing signal is recorded outside of and separate from the audio signal by an echelon synchronizing head. In reproduction the synchronizing signal is amplified and drives the film movement at the correct speed to conform with the audio signal on the tape. This is in contrast to earlier equipments wherein the speed of the tape is made to conform with the speed of the film drive. A special feature of this system is the Re-Synchronizer which is used to bring the picture and sound start in synchronization, thus making possible dual-film presentation of picture and ¼-in. tape. In this system special synchronous motors are used to control the speed and not necessarily to drive the sprocket film transport.

Figure 1 shows a synchronous generator of the type used on the Arriflex 35mm d-c constant speed motor. Figure 2 is the synchronous generator used on an Eastman Kodak Cine Special 16mm spring-driven camera. A transformer is used to reduce the 110-v power line voltage to 1 v when this equipment is used with cameras driven by synchronous motors. The sync generator, Fig. 1, is a two-pole permanent magnet generator geared down to operate at 3600 rpm and develop 1 v of 60-cycle power. This is adequate to drive the synchronizing record head without the use of amplification or batteries. The sync generator, Fig. 2, which is driven directly by the 1440-rpm shaft of the camera, produces 1 v of 48 cycles, which is used as the synchronizing signal.

The echelon synchronizing recording head is shown in Fig. 3. It records two soundtracks in phase, but displaced in echelon on the edges of the audio tape outside of the audio signal. The echelon displacement of the two recording slits is a distance equal to one-half the wavelength of the synchronizing signal. The signals during recording and reproduction are in phase, but any crosstalk signal into the sound area is out of phase. This in-phase echelon arrangement has many advantages. With two separate soundtracks the problem of dirt pile-up is effectively eliminated. The heads overlap the edges of the tape, so even with bad weave, at least one of the heads is in contact with a synchronizing track. The synchronizing tracks are outside of the audio track so they do not cause print-through, crosstalk or intermodulation troubles. The two heads give continuity, due to horizontal averaging of two tracks. The echelon feature adds further reliability and continuity, due to the longitudinal averaging of the two heads. This is very important in reproducing spliced tape, such as tape that has been edited. The echelon heads can be used with or without bias. These heads are used both for recording and reproducing the synchronizing signal.

During reproduction the signal picked up by the echelon head may be amplified with any amplifier capable of reproducing magnetic sound, provided that the last stage of the amplifier has adequate power. The power of the last stage should be at least 60 w, if the amplifier is to drive the synchronous motor of a film transport or projector without augmenting power. A 20-w power amplifier is adequate in cases where a controlled universal motor is used to augment the sync drive in accordance with a system devised by Magnetic Sales Corp.

The amplified synchronizing signal drives the film transport at the proper relative speed with respect to the tape, but if the picture starts late or early with respect to the tape, the entire scene will be out of synchronization. If, however, a Re-Synchronizer is used, it is possible to shift the picture with respect to the tape, thus effecting exact synchronization. The Re-Synchronizer, Fig. 4, is unique and simple. It changes the length of tape between the audio pickup head and the sync pickup head. As this length of tape is increased, the picture is retarded and as the length of tape is decreased, the picture is advanced. In addition to placing the picture in synchronization with the sound at the start of each reel, the Re-Synchronizer can be used to change and/or correct the synchronization any time during projection.

The frequency used for synchronization is usually 60 cycles for 35mm professional work and/or when the sound is to be resolved onto sprocket recorders driven by 60-cycle synchronous motors. 48 cycles is used as the synchronizing frequency for most 16mm and 8mm photography shot at 24 frames/sec. A

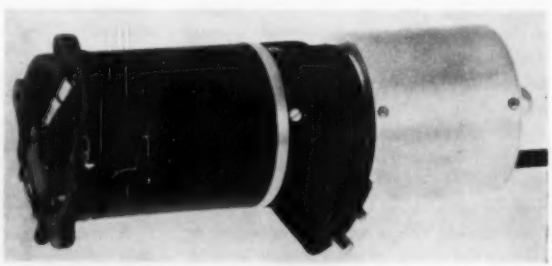

Fig. 1. Sync generator mounted on 35mm Arriflex governor-controlled d-c motor.

Presented on May 2, 1960, at the Society's Convention in Los Angeles by Loren L. Ryder, Ryder Sound Services, Inc., 1161 N. Vine St., Hollywood 38.
(This paper was received on April 3, 1961.)

frequency between 32 cycles and 36 cycles is used for most so-called 16-frames/sec work.

Synchronizing heads and Re-Synchronizers with proper heads are available for ¼-in. full-track recording, binaural stereophonic recording and for half-track recording.

Most 16mm and 8mm projectors have a hand knob attached to the shutter shaft. A synchronous motor can be connected to this shaft and either used to drive or control the speed of the shaft. In the Magnetic Sales Corp. alteration, the Lee governor motor speed control is wired to a contactor on the synchronous motor so that the Lee control makes the universal motor follow the speed of the sync motor.

In operating with these equipments the start mark is established in the usual manner with clapsticks. If the ¼-in. tape is reproduced dual-film in synchronization with the picture, the synchronizing picture clap is threaded in the projector gate and the sound clap is threaded about 2 in. ahead of the audio reproduce head. The tape is threaded around the Re-Synchronizer with the arm about half open. When the tape reproducer is started, the synchronizing signal from the tape reproducer is amplified and starts the projector. If the picture and sound are not in exact synchronization, a correction is made with the Re-Synchronizer. If the displacement of the sound synchronization is once determined for reproducer and a projector, the sound and picture should always come up to speed in synchronization. However, as contrasted to all previous systems of dual-film presentation, the Re-Synchronizer is always available to shift synchronization, should such a shift be found necessary.

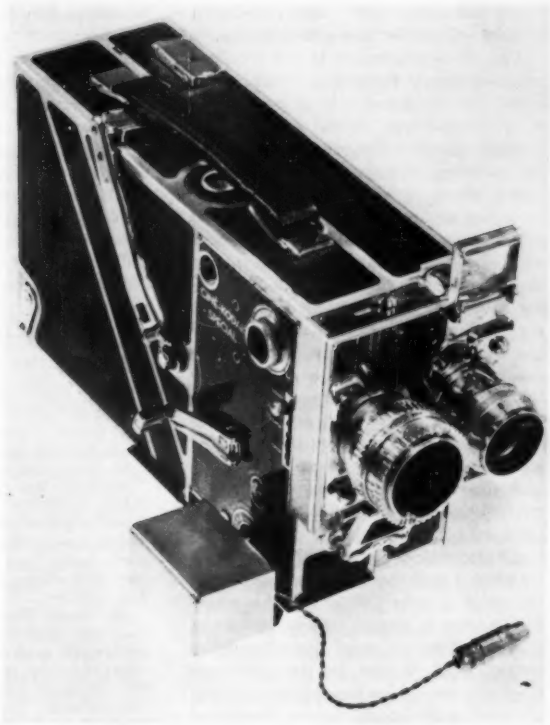

Fig. 2. Sync generator mounted on Eastman Kodak Cine-Special.

People of experience are now using the Re-Synchronizer to synchronize wild or nonsynchronized photography with wild and nonsynchronized recordings. The use of clapsticks is recommended for wild shooting, the same as for synchronized shooting, at least until the operator is familiar with the performance of the equipment. The picture and sound are threaded on the projector and tape reproducers in the same manner as described above. With a little experience an operator will determine the rate of drift between picture and sound and compensate for this drift with the Re-Synchronizer as the scene progresses. After gaining a satisfactory rehearsal, a sprocket-driven recorder can be added to the electrical circuit using a separate power amplifier for the synchronous drive. When the tape reproducer is started, the synchronizing signal will start the projector and recorder. In so far as the sound and picture are held in

Fig. 3. Echelon synchronizing head.

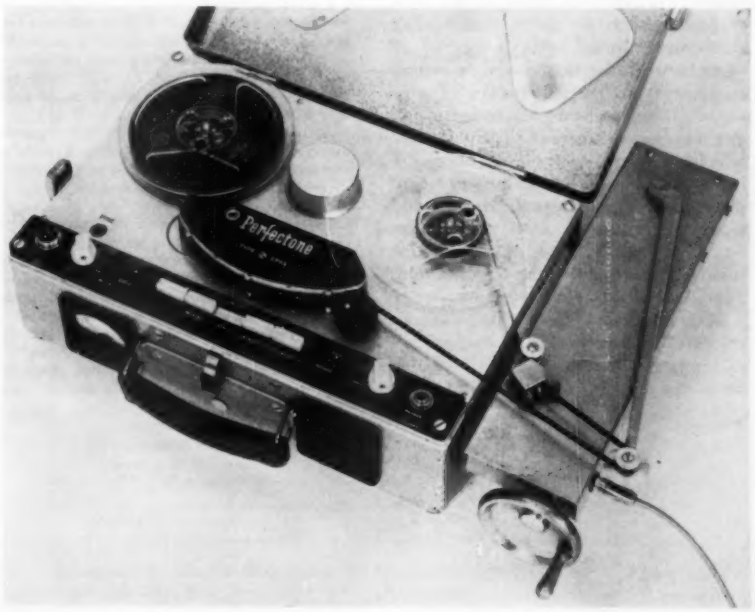

Fig. 4. Re-Synchronizer mounted on right-hand side of Perfectone Recorder.

synchronization, the sprocket-driven transfer will also be in synchronization.

The Re-Synchronizer is not required in cases where there is a synchronous signal and the sound is to be transferred to sprocket-driven optical or magnetic film. In this case the echelon head may be mounted directly on the recorder panel where it will be used both for recording and reproduction. It should be pointed out that if a Re-Synchronizer is used, the echelon magnetic head on the Re-Synchronizer can be used for recording as well as reproduction. In this case the Re-Synchronizer and echelon head can be moved from one recorder to another recorder and thus gain greater interchangeability of equipment.

The use of a low-power-level synchronizing signal with an extremely good signal-to-noise ratio, such as is obtained with the echelon head, makes many new possibilities feasible. If this equipment is used in conjunction with a 16mm or 8mm magnetic projector, the picture can be striped and the sound transferred to the stripe. Further, if the sound is transferred prior to picture editing, it may be transferred in editorial synchronization (sound and picture in straight-across synchronization) for easy picture editing, after which the sound can be transferred to projection synchronization for presentation. Alternately, if the picture and sound are edited prior to picture striping, the sound can be transferred directly to projection synchronization for immediate presentation. If the Re-Synchronizer is used, the picture and $\frac{1}{4}$-in. tape can be telecast dual-film with complete assurance of synchronization. Furthermore, should any scene be edited out of synchronization, it can be re-synchronized as the picture is projected.

The low-level synchronizing method makes it possible to transmit the synchronizing signal by radio, thus gaining synchronous sound without the use of wires between the camera and recording equipment. A wireless system of synchronization can be expanded to include any number of cameras and any number of recording equipments — all operating in synchronization. In this system where the synchronizing signal is recorded separately from the audio signal, the synchronizing signal may also be used for vocal and/or coded cue information, individual camera starts, stops, etc.

Magnetic Sales Corp. has also developed a transistorized automatic remote start and stop which is available when this system is used with Perfectone recorders. In this case the recorder starts and stops under the control of the camera switch. This is now standard practice with the equipments furnished by Ryder Sound Services, Inc., in Hollywood.

Fortunately, the systems described in this paper are generally compatible with other systems. The echelon synchronizing heads may be used on any make of tape resolving equipment. The techniques described in this article may be used in full or in part, reverting back to the older procedures for certain steps until the user gains confidence and familiarity with the overall system.

Discussion

George Lewin (*Army Pictorial Center, Long Island City, N.Y.*): Do I understand correctly that there's a longitudinal displacement between these two echelon heads along the tape?

Mr Ryder: That is correct.

Mr. Lewin: How far apart are they?

Mr. Ryder: The displacement is normally $\frac{1}{2}$ wavelength of 60 cycles, which is about $\frac{1}{16}$ in. for a tape speed of $7\frac{1}{2}$ in.

Mr. Lewin: Does this separation limit you in very close editing, or if you want to edit the $\frac{1}{4}$-in. tape?

Mr. Ryder: The echelon separation of the heads aids synchronization when going across a splice under conditions where the synchronizing signal is spliced at or near 180° out-of-phase. In other words, it is an advantage rather than a disadvantage.

Mr. Lewin: In regard to the absolute speed, I understand how the system is kept in synchronism, but as I understand it the absolute speed at which it plays back is still a function of how accurately the tape recorder reproduces its speed. In other words it won't necessarily play back at exactly the speed at which it was recorded.

Mr. Ryder: Your statement is correct with respect to location shooting. However, the real determining factor is the camera speed.

Even though the speed of the camera may drift during photography, it will ultimately be played back at exactly 24 frames/sec. The sound that accompanies and synchronizes with the original picture must likewise be slowed down or speeded up in order to stay in synchronization with the picture.

I would point out that the tolerance of speed for the old Westrex and RCA distributors was $\pm\frac{1}{2}$ of 1%, whereas, the manually controlled inverters that are now being used on location have a normal swing from 23 to 25 frames/sec and sometimes greater. I know of no occasion where this has caused trouble.

As contrasted to the present inverter system, the new governor-controlled motors, such as are used on the Arriflex cameras for location shooting, hold their speed constant to within $\pm\frac{1}{2}$ frame.

In the Perfectone system of recording, the recorder drives at constant speed irrespective of any camera speed changes. All compensation for variation in camera speed is made during transfer, thus providing the possibility of special equalization for the camera speed changes.

The Perfectone recorder has a jewelled centrifugal governor which operates through a transistorized speed control resetting the speed approximately 16 times/sec. The voltage across the contacts is about 0.4 of a volt and the current across the contacts is about 5 μa. This gives the most accurate and reliable location speed control known to the author.

Mr. Lewin: I was wondering about the method you outlined of bringing the picture and sound into synchronism. Do you think you can accurately come within one frame consistently? Because it seems like somewhat of a cut-and-try method rather than a rigid one for lining up the stop marks.

Mr. Ryder: The accuracy of this method is dependent upon the fact that a given camera and/or a given projector, as well as the associated tape machines, start very consistently with a given amount of lag. Synchronously driven cameras usually start in a frame and one-half $\pm\frac{1}{2}$ frame. Synchronously driven projectors usually start in two and one-half frames $\pm\frac{1}{2}$ frame. The Perfectone recorders start in approximately a frame $\pm\frac{1}{2}$ frame. If a clapstick camera check of synchronization is made for a given camera or if clapsticks are used on the first two or three camera scenes, the operator will find that he can compensate accurately and bring each clapstick into synchronization without trouble.

We are using this same system of synchronization to synchronize sound from $\frac{1}{4}$-in. tape to the soundtrack of video picture tape. The eye of an expert becomes so much better than the eye of an audience that there seems to be little or no trouble in gaining satisfactory synchronization.

T. C. Sharp (*RCA, Los Angeles*): Why would the machine change; is it due to the drag on the second time it was started? Why doesn't it remain the same for the first? If it is changing is there a drift, as a different size reel or take-up?

Mr. Ryder: In my previous discussion I have only mentioned the relative starting time and I probably should have pointed out that the stopping time is equally important if there is more than one take to be projected in continuity. If the sum of the start and stop time of the projector is equal to the sum of the start and stop time of the camera and this is also equal to the start and stop time of the recorder, one can see that when synchronization is once established, the synchronization will be maintained throughout a series of takes. Normally, this condition does not exist, but if clapsticks are used for the first two or three takes with a given combination of equipment, it will be found that certain amounts of correction, usually one to three frames, will be required between takes and if this correction is made, synchronization will be maintained. There is no drift in the synchronization once it is established.

Rolf Epstein (*National Film Board, Canada*): How is the noise problem solved? The Arriflex and the 16mm camera cannot be used very well for sync shooting without an efficient blimp.

Mr. Ryder: That is a good point. The discussion has centered about a synchronizing method between a camera and a recorder and so far, the audio problems and the photographic problems have not been touched upon. It is true the Arriflex is a noisy camera. There are cameras that are not as noisy. We use barneys, we use blimps; but we're shooting many feature motion pictures with these lightweight cameras and one might say "getting away" with the noise. I think that is it high time that somebody developed a really quiet 35mm camera. As far as I know this has not been done. In the 16mm field we have cameras that are quiet enough to be satisfactory.

A New Cartridge-Type Projector

for Home Motion Pictures and Other Applications

By WALTER BEYER

A new cartridge-type projector for home motion pictures is described. This projector makes possible the showing of a full-length feature film in a condensed form without the need of threading. The specific method of obtaining a film to be enclosed in a cartridge is described, and based on this system applications for the educational field are outlined.

A CAREFUL STUDY of the potentialities of movie showings in homes has revealed that the desirability of home movie shows has not decreased; but the cumbersomeness of existing projection equipment and the volume of film needed for a home movie show have caused such activities to decline. Statistics, however, show that every feature-length film for theater release is advertised to at least twice, even three times, as many people as actually buy tickets. Recognizing the existence of a home movie market has led to the development of equipment that will eliminate all of the above shortcomings; and a set of specifications was worked out to which such a home movie system should respond. They are, in brief, as follows:

(1) elimination of threading projector for each use,

(2) utilization of magnetic sound track,

(3) improvement in quality of picture and sound,

(4) reduction of bulk and weight,

(5) capacity to project a feature-length film in one operation, and

(6) principles related to economy of production.

The solution was found in the form of a cartridge-type magazine of sufficient size. The images are printed up and down to allow half a full length film (110 minutes) on one side with the second half contained on the other side. A symmetrical magazine arrangement allows projection of both halves by merely turning the magazine around 180 degrees and reinserting it in the projector. Subsequent engineering fulfilling the requirements and incorporating the magazine principle resulted in the prototype model, Mark I, Cordova Projector.

It is pertinent to disclose investigation involving our attempts to utilize standard reduction prints. For 8mm reduction printing, it was determined that the quality requirement was not satisfied. 16mm had to be rejected since its image size would have resulted in a magazine, not only wider, but so large that a double magazine would be required for a feature film. The two steps are indicative of the many considerations given to utilizing either one of the established and standardized small film formats.

The basic elements of the Cordova Mark I projector system are: the method of making the film, the design of the cartridge, and the actual projector for receiving the cartridge. All elements will be described separately in sequence.

A. Film

The original material is a 35mm release negative in either black-and-white, or color. This negative is optically reduced in the ratio of 2.66: 1 on another piece of 35mm film running at a reduced speed at a ratio of 4 : 1. In other words, a four-perforation image of the original is reduced to a one-perforation image on one side of another 35mm film.

The schematic drawing of Fig. 1 shows, in detail, all dimensions for apertures, soundtrack location, perforations, etc., displayed within a piece of 35mm film drawn to scale.

This 35mm secondary film has standard 35mm dimensions with an added row of perforations exactly along its centerline. The center perforation is 16mm standard perforation in size, having the same pitch as the 35mm perforation, namely 0.187 in.

The reduced images appear 0.010 in. alongside this center perforation and reduced image size on this film equals 0.310 in. by 0.177 in., which represents a 1.75 aspect ratio. Adjacent to the images to the outside edge of the film is a space approximately another 0.010 in. Away from the printed picture are two magnetic soundtracks, each approximately 0.040 in. in width. A magnetic sound recording is applied to these tracks with a recording head having the width of 0.038 in. There is a specific amount of clearance outside each of these soundtracks. The total width of the final magazine release film equals 0.8125 in. The optical reduction is done in black-and-white on a dupe negative, and color in form of the matrix for IB printing, both being on standard 35mm film. The film is then contact printed in the usual manner, the final release material being 35mm in width. After processing, this final 35mm film receives its center perforations. Still remaining a piece of 35-mm film, it is coated with the two magnetic tracks as described above on its base side.

As 35mm film, the sound is recorded magnetically. A displacement of 50 frames between sound and picture start is required by the projector design which is described later. The picture start is presently 50 frames ahead of the corresponding sound.

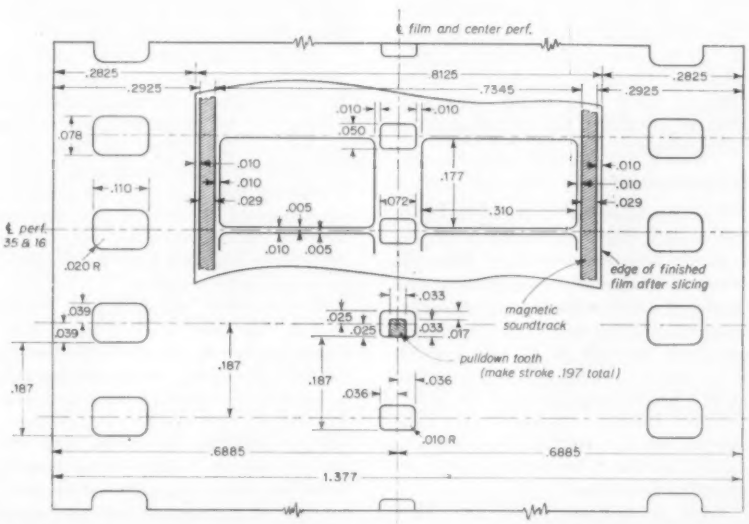

Fig. 1. Schematic drawing of dimensions for apertures, soundtrack location and perforation for the cartridge film.

Presented on May 16, 1961, at the SMPTE Hollywood Section Meeting by Walter Beyer, Head of Engineering at Universal Pictures Company, Inc., Universal City, Calif.; and Chief Consulting Engineer, Cordova, Inc., 8654 Wilshire Blvd., Beverly Hills, Calif.
(This paper was received on March 27, 1961).

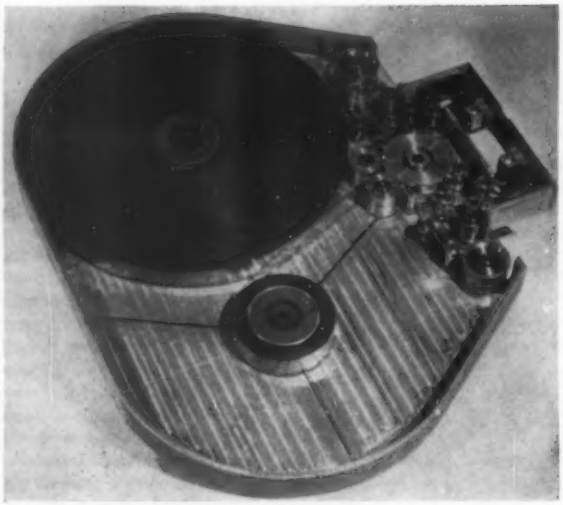

Fig. 2. Cartridge of Cordova Mark I Projector with full-length feature; cover removed to show film.

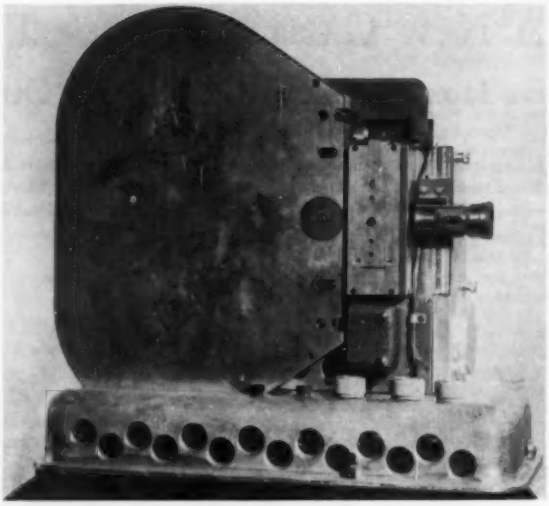

Fig. 3. Cordova Mark I cartridge projector ready for operation (view from operator's side).

This means that all printing, processing, magnetic striping and sound recording is handled by high-quality, professional 35mm technique and equipment. No special or substandard methods are necessary.

After printing, perforating, cutting and recording the standard 35mm perforations are sliced off leaving a finished product of 0.8125 in. wide with one row of 16mm perforations along its centerline. This final release film carrying the images and sound is now ready to be loaded into the magazine.

A reel of this film having a 2-in. hub diameter with 9.5-in. outside diameter equals a total length of 1.250 ft. Since the images are printed up and down this represents total footage of 2,500 ft. With a reduction ratio of 4 : 1, this is the equivalent of a 10,000-ft full-length feature film. This film capacity allows 55 minutes of running time for one-half reel, or 110 minutes total available running time. An average feature film is roughly 9,000 to 9,600 ft in length. Film subjects of less length can be mounted to suit the requirement.

B. Magazine

The magazine, as presently designed, is entirely symmetrical for the purpose of a simple turnover procedure. It carries two 2-in. cores with a special film clamp device. It has a common feed and supply sprocket. The pressure plate for two apertures, as well as additional guide rollers and drums, provide a tight loop to allow a simple magnetic sound pickup.

Figure 2 shows a magazine ready to be inserted into the projector, threaded with 1,250 ft of film. (The cover has been removed to show film.)

Such a magazine will be filled, threaded, then sealed or enclosed in a semipermanent manner so that the ordinary user has no access to its contents. The film is physically exposed only on its base side at the aperture and the areas above and below the aperture housing. All of these openings will be covered by a simple sheet metal protective attachment during shipment. The magazine will be marked on the cover as to "TOP — FIRST HALF" and on the other side "TOP — SECOND HALF," indicating which side is to be shown.

A simple means of suspending the cores as well as the sprocket prevents the film from displacement and unrolling during transportation. The proper suspension for all three film carrying devices (cores and sprocket) is provided in the projector in order that expensive bearings need be provided only once in the projector and not in each magazine. The magazine is entirely smooth on the outside so that handling is facilitated and damage potential virtually eliminated.

Extensive tests have shown that the takeup and mechanical operation of the magazine is completely trouble-free. The front part of the magazine has a housing around the film loops and apertures, that forms the precise mechanical connection of the magazine with the projector when inserted. This front part also has precision machined holes into which registration pins lock after the magazine is inserted in the projector.

The prototype magazine, for several reasons, has been made from a solid aluminum casting. On production models only the front part, which will have an adjusted carrier plate for the sound pickup roller arrangement and the apertures, will be precision machined. The rear portion can be a sheet metal housing manufactured in a punch-and-die process. The film transportation mechanism of the magazine can be pre-assembled and tested for its proper function prior to assembly with sheet metal housing that completes the enclosure of the two film reels.

C. Projector

The projector is designed so that the magazine can be inserted from the rear guiding on a slot provided in its base. The pulldown movement and shutter located in the space between the film and lens engage and work properly after the magazine is inserted. Figure 3 shows the projector from the operating side with the magazine ready to run. Figure 4 shows the opposite side, including the engagement shafts.

For safety reasons the movement claw and its carrier are spring-loaded away from the magazine which prevents damage in the event there is no perforation hole opposite the claw pin when the magazine is inserted. In a production model the magazine will have a self disengaging register pin to maintain a specific position of the perforation with respect to the movement pin at all times.

With the magazine inserted as far forward, toward the lens, as possible, the front door carrying the mirror for the illumination system and the registration pins is closed. The three shafts for sprockets and film reels are engaged.

The projector is equipped with a synchronous drive motor. Its main shaft is geared to drive the movement and shutter. A gear reduction shaft drives the takeup sprocket and takeup friction. All drives are flexible belts which significantly reduce noise and require less maintenance than gears.

All bearings are made with self-lubricating Teflon bushings that require no maintenance during the lifetime of the equipment.

The lamp used is the new Sylvania Tru-Flector lamp which has a built-in

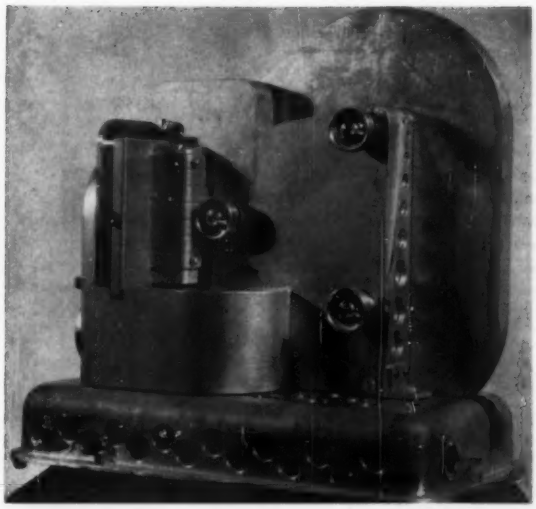

Fig. 4. Rear view of cartridge projector showing lamphousing, motor cover and engagement shafts.

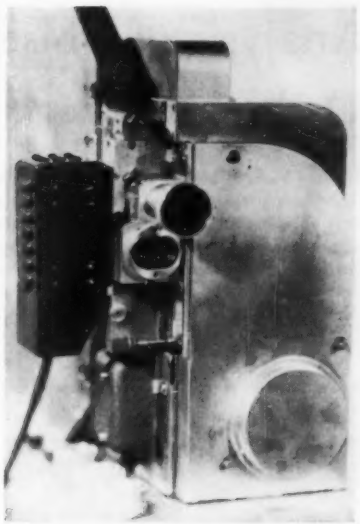

Fig. 5. Attachment of additional lamphouses and split lens arrangement with dual lens carrier for 3-D showing.

reflector system. It requires no cooling blower which, of course, eliminates that source of noise. The electrical input of such a lamp is 150 watts with a light output equivalent to a 500-watt lamp. This illumination system requires no condenser, with resultant economy in manufacturing.

The projector operates at 24 frames/sec which is equivalent to a continuous film speed of 4.488 in./sec. The basis of the decision to deviate from optical sound reproduction utilizing magnetic sound was twofold. An optical sound pick-up for a cartridge-type machine would have caused extensive disadvantages in design and consequently in price. On the other hand magnetic sound lends itself excellently to the basic design and offered quality commensurate with Hi-Fi.

Electrical wiring to the lamp and motor are in the base of the projector which also houses the amplifier for the magnetic sound reproduction. Push-buttons, amplifier switch and sound control buttons are all in line on top of the base on the operator's side of the projector. The speaker for sound reproduction is built into the cover used for transportation and storage.

Since the projector is equipped with a transistor amplifier, it requires no warm-up time and the sound is available instantaneously when the picture is projected. At the end of the first half of the magazine, a cutout section in the film causes the microswitch to release the relay that automatically stops the projector. The projector will not run any further or tear the film from the supply carrier, if someone should press the "ON" button again before turning over the magazine.

After turning over the magazine, the projector will run only after the "ON" button is pressed again and will continue until the automatic "stop cutout" at the END of the film is reached. Further provisions are foreseen to prevent the projector from running if the film reels and sprocket drives are not properly engaged with the magazine.

This projector also will possess a 3-D capability. Stereo attachment on the projector will provide perfect registration superimposure for a 3-D picture. The two soundtracks can be utilized for stereophonic sound reproduction.

The left and right eye camera images will be printed side by side so that they can be projected simultaneously. The projector will be equipped with a second light source (matched with the lamp already provided) so that each light source will illuminate one of the two images.

Figure 5 shows the projector with the additional lamphouse and dual lens for 3-D projection. This lens is added on a sliding device which will easily permit shifting lens carrier up and down for regular and 3-D projection.

The production model is designed so that the same magazine and the same projector will be capable of showing either up-and-down single-image, superimposed 3-D or double-image side-by-side projection.

Utilization

Projection of feature films in forward areas, on board ship or aircraft would be simplified tremendously. Unskilled operators can use the machine as easily as trained personnel. The advantages of handling and maintaining the film itself in the magazine concept is operationally significant. The economy of distribution over present methods is great. The cost of repairing or replacement of prints would be reduced to a minimum.

Utilization of this projector, as presently designed or modified, in the training film field would have advantages comparable to those listed above. In addition, specific application for language training, combat tactical simulators, aircraft landing training and many other training aid uses offers inherent advantages.

A single-lens attachment covering the area of both apertures would allow side-by-side pictures on the screen. Advantages for specific types of training films and engineering data recording could be significant in this capability of the projector.

Testing and evaluation application in examining engineering data film can be simplified for effective interpretation.

For data reduction and evaluation, particularly where information is voluminous, a reduction to the type of print handled by this projector will reduce the amount of film necessary and make inspection more facile, either single-frame, double-frame or 3-D, all in stop motion.

Other uses are numerous. Many may be provoked through examination of this material and witnessing the demonstration of the projector.

Analysis of Noise in the Image Orthicon

By B. H. VINE

The problem of how to design a camera tube to operate at light flux levels lower than those presently used without reduction of the signal-to-noise ratio is examined. It is shown that any increase in photocathode sensitivity or mesh transmission allows a corresponding reduction in the light required for equal performance. On the other hand, increases in the secondary-emission ratio of the target or the first dynode, even if indefinitely large, can only produce a limited reduction in the light required for equal performance.

Introduction

At low light levels, the dominant feature in the performance of a camera tube is the noise in the transmitted picture. This paper examines the processes occurring within the image-orthicon camera tube and calculates the noise contributed by each process. The signal-to-noise ratio at the tube output is obtained and expressed in several ways.

Fundamental Noise

Even with the steadiest, most uniform illumination on the light-sensitive surface of a camera tube, individual photons arrive at this surface at random. This randomness which is both in time and in space, is an irreducible source of noise.

Consider one television-picture element of an image projected on the sensitive surface. According to statistical theory, if an average number N of photons falls on this element per frame time, the rms deviation from the average will be $\sqrt{N}$. The deviations are noise, and the ratio of the signal amplitude N to the rms noise amplitude $\sqrt{N}$ is $N/\sqrt{N}$ or $\sqrt{N}$. An ideal camera tube would count all the photons falling on it and exhibit the same fluctuations in its electrical output as in the photons. The electrical signal-to-noise ratio would be the same as the above photon signal-to-noise ratio. A real camera tube yields a signal-to-noise ratio less than $\sqrt{N}$. In the case of the image orthicon, it will be shown that the signal-to-noise ratio of the real tube is less than that of the ideal tube by a factor which is characteristic of the particular tube. This calculation is readily made for monochromatic light. However, for white light it is necessary to choose arbitrarily a wavelength band within which to count photons. In order to avoid making such a choice, the analysis is put in terms of the average number of photoelectrons emitted from a given television element of the photocathode per frame time.

Presented on May 6, 1960, at the Society's Convention in Los Angeles by B. H. Vine, Electron Tube Division, Radio Corp. of America, Lancaster, Pa.
(This paper was received in final form on May 10, 1961)

Signal-to-Noise Ratio of the Image Orthicon

The general form for the signal-to-noise ratio of the image orthicon calculated in Appendix I is specialized to the case of highlight signal-to-noise ratio in Appendix II. The relation obtained between the number of photoelectrons n_0 emitted from a highlight picture element and the signal-to-noise ratio R_0 is

$$n_0 = R_0^2 F \tag{1}$$

The dimensionless factor F contains the tube parameters. Ideally, F would be unity, but in typical tubes it has a value of about 4.

Eq. (1) may also be expressed as follows:*

$$\frac{I_0 A S}{2e\alpha B} = R_0^2 F \tag{2}$$

This relation which gives R_0 as a function of the highlight photocathode illumination I_0 is shown in Fig. 1 for a sensitivity S of 60 μa per lumen† and a tube factor F of 4 with remaining factors corresponding to commercial television standards. These values are typical for a Type 5820 image orthicon; measurements made on image orthicons fall close to this curve. A second and higher curve in which S is 150 μamp per lumen and F is 2.5 represents a reasonable goal for image orthicon improvement, as discussed below.

* The definition of symbols and the derivation are given in Appendix II.
† The lumen used in this paper is that of 2870 K tungsten light.

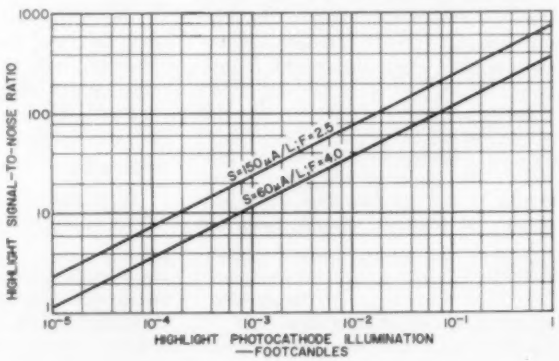

Fig. 1. Highlight signal-to-noise ratio as a function of highlight illumination.

Possibilities for Improvement of Image Orthicons

Equation (2) indicates that an increase in photocathode sensitivity allows a corresponding decrease in photocathode illumination for a given signal-to-noise ratio. Ultimately the 150 μamp-per-lumen multialkali (S-20 response) photocathode will replace the less sensitive photocathodes if processing problems which restrict its use can be removed. Any substantial increase in photocathode sensitivity beyond that of the multialkali type appears unlikely.

For comparison, an ideal photocathode having eye response and unity quantum efficiency (i.e. one photoelectron for each photon) at the peak of the response curve would have a sensitivity of 682 μamp per lumen. An ideal photocathode with a rectangular spectral response having a quantum efficiency of unity throughout the visible region and zero outside it, would have a sensitivity of about 2000 μamp per lumen.

An examination of the expression for F in Appendix II shows that any increase in the transmission factor η of the mesh on the photocathode side of the target results in a corresponding decrease in illumination required for a given signal-to-noise ratio. The 750-line-per-inch electroformed mesh has a transmission factor η of about 0.6. It appears unlikely that an appreciable increase in η could be obtained without making the mesh coarser or substantially weaker. Moreover, η is rather close to unity already, and any advantage gained by increasing it would be small.

Another important parameter is the secondary-emission ratio δ of the target for electrons from the photocathode. Figure 2 shows the factor F as a function of δ; other parameters were chosen to bracket their usual range of values. From Eq. (3), the illumination required for a given value of R_0 is proportional to F, and an increase in δ reduces F and

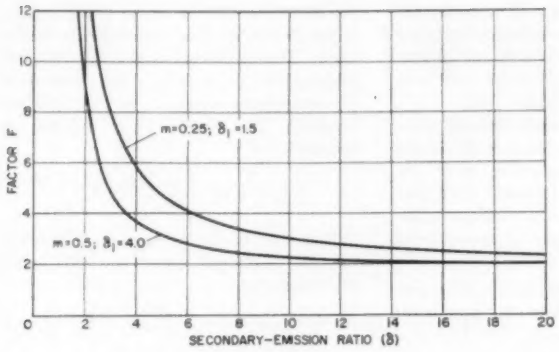

Fig. 2. Variation of the factor F as a function of the target secondary-emission ratio.

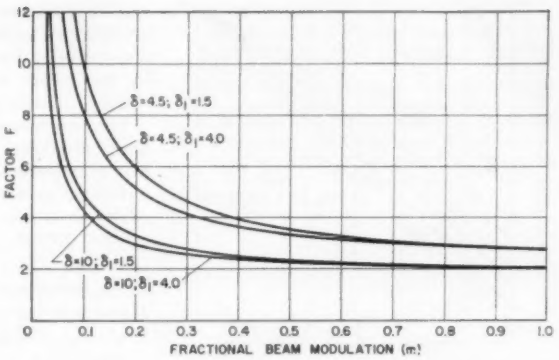

Fig. 3. Variation of the factor F as a function of the beam modulation.

consequently reduces the required illumination. In present glass-target tubes, the secondary-emission ratio is about 4 or 5 and the corresponding value of the factor F is about 4. In tubes using magnesium-oxide targets, the secondary-emission ratio is of the order of 10, and the value of F is about 2.5. Further increases in δ beyond 10 yield only slight reductions in F, and hence only slight reductions in the light required for a given signal-to-noise ratio.

Variation of the factor F as a function of beam modulation m is shown in Fig. 3; other parameters were chosen to bracket their usual values. Because the usual values of m are 0.25 to 0.5, only moderate reductions in the illumination required may be achieved by improvements in beam modulation.

To a limited extent, increases in m are as useful as increases in δ. However, best possible tube performance requires that both δ and m be high.

Noise in the Picture Lowlights

The preceding discussion is based on the highlight signal-to-noise ratio (ratio of highlight signal to rms noise in the highlights) obtained when the beam is just sufficient to discharge the highlights.

Because the image orthicon beam is ordinarily maintained constant, more than sufficient beam is used in the lowlight areas. The values of the internal tube parameters which combine to yield F=4 are typical of those measured on most RCA glass-target image orthicons such as types 5820A, 7293A, 7295A, 7390A, 7513, and 4401. The values of measured signal-to-noise ratio for a given light level for such tubes fall close to this curve, in most cases within the experimental error of measurement of signal-to-noise ratios in television signals.

Equation (5) in Appendix III shows the signal-to-noise ratio variation from highlight to lowlight areas. (Lowlight signal-to-noise ratio is taken as the ratio of the lowlight signal to the rms noise in the same lowlight). The variation of signal-to-noise ratio as a function of illumination in a given scene as obtained from Eq. (5) is plotted in Fig. 4 for a number of values of δ. It is evident that very high values of δ would be useful in improving the lowlight signal-to-noise ratio, but only modest improvement can be obtained with foreseeable increases in δ.

Discussion of the Analysis

Unless otherwise stated, the definitions of terms used in the analysis are IRE Standard Definitions.[1]

Because of problems connected with the storage of signal charge on the target, no single image orthicon can perform well over a wide range of highlight tube illuminations. A given tube will be represented by the lines of Fig. 1 only over a range of illuminations of the order of 100 to 1. At high light levels saturation of the charge stored on the target will set an upper limit to the signal-to-noise ratio. At low illuminations the beam modulation m (which was assumed constant in the analysis) is known to become lower. This causes the observed signal-to-noise ratio to be lower than predicted by the lines of Fig. 1. If m is lowered due to low illumination the lag also becomes excessive.

It has been assumed that δ is the true secondary-emission ratio. The expressions are thus correct only under the knee of the image orthicon transfer characteristic. In the region near the knee, it is reasonable to substitute an effective value of δ based on the number of secondary electrons collected. The second term in the expression for F is not correct when an effective[4] value of δ is used, but this term is usually small. The analysis is not valid above the knee of the transfer characteristic.

Beam noise is taken as full shot noise for the magnitude of the beam current incident on the target. The beam may be said to be temperature-limited, even though the current emitted from the thermionic cathode is space-charge limited because the beam in the image-orthicon gun is formed by a small aperture which intercepts a large fraction of the thermionic cathode current and passes only the small remaining fraction as beam current. Under these conditions, the total noise in the beam is very nearly equal to full shot noise for the magnitude of the beam.[2]

Similarly, the photoelectron noise has been taken as full shot noise for the portion of photoelectrons transmitted by the mesh on the photocathode side of the target. This figure is not an approximation when the incident photoelectrons already have full shot noise.

In Fig. 4 the limiting line having a slope of 1/2 is the limiting case in which photoelectron noise is completely dominant; the limiting line having a slope of unity is the limiting case in which beam noise is completely dominant. In the latter case, the noise amplitude is constant. The calculated lines fall between these limits and indicate that the noise amplitude in the lowlights should be somewhat less than that in the highlights. In practice, the difference between highlight and lowlight noise amplitudes has been almost unobservably small.

A possible explanation of the failure to observe such a difference is a phenomenon which has not been included in the analysis of this paper: It has been assumed that all noise in the beam approaching the target is reflected into the return beam. A more detailed analysis shows that a portion of the higher frequency components of the incident beam noise tend to go into the target circuit when part of the beam is being deposited. This noise does not appear in the return beam. This effect tends to reduce the noise in the highlight below that given by the expressions in this paper. The expected magnitude of this effect is of the order of 15 to 20 per cent reduction in noise amplitude at the highest frequency transmitted (normally 4.5 mc).

Comparison With Earlier Figures

Janes et. al.[3] *calculate* the signal-to-noise ratio of a type 2P23 as 25. They also show the knee of the 2P23 at 0.017 ft-c. The point so defined falls below the lower curve of Fig. 1 herewith, as it should, since the photo-

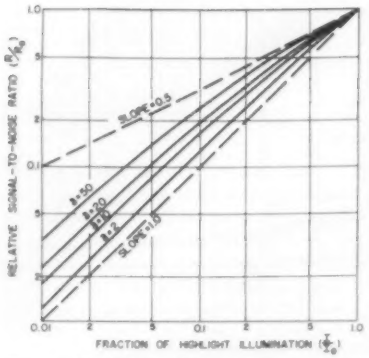

Fig. 4. Variation of the signal-to-noise ratio within a given scene.

cathodes at that time were less sensitive than now and the beam modulation was also lower. Similarly, for the type 5655, they give signal-to-noise of 80 at 0.17 ft-c which is also below the curves shown in this paper.

A paper by Weimer[4] on the Isocon mentions a signal-to-noise of 100 but this is neither observed nor calculated, but merely a nominal value for convenience of discussion.

The probable foreseeable limit for signal-to-noise ratio for the image orthicon is about the higher curve of Fig. 1.

It should be mentioned that television noise measurements are not very satisfactory. Many measurements are made by visually estimating the peak-to-peak height of the "grass" on an oscilloscope and dividing by a factor which varies from 6 to 9 to get rms noise. There have been more precise methods used, but they require careful work to obtain reliable results.

APPENDIXES

I. Basic Analysis

Consider one television picture element of the image-orthicon photocathode on which steady illumination falls. Let the average number of photoelectrons emitted from this element per frame time be n. These electrons are liberated individually and collectively at random. According to statistical theory the rms deviation from the mean value will be $\sqrt{n}$. Because the n electrons are signal and the deviations are noise, the ratio of signal charge to noise charge is $\sqrt{n}$.

If the transmission factor of the mesh through which these photoelectrons pass is η then the average number of electrons reaching the mesh will be ηn; and, assuming that the mesh removes electrons at random, the rms deviation will be $\sqrt{\eta n}$. The signal-to-noise ratio of electrons reaching a target element is then $\sqrt{\eta n}$.

If the average number of secondary electrons emitted by the target per incident primary electrons is termed δ, and it is assumed that all secondaries are collected by the mesh, both the signal and the noise already computed appear on the target multiplied by the secondary-emission gain factor (δ-1).

The secondary-emission process produces additional noise because the number of secondaries resulting from an individual primary is variable. The rms deviation is taken as the random noise on the average number of secondaries or $\sqrt{\delta \eta n}$.

If n_b electrons are used in the beam per picture element per frame, the shot noise in the return beam is $\sqrt{n_b}$.

A total of $n_b - (\delta - 1)\eta n$ electrons are returned to the multiplier. The shot noise on the emitted secondaries is as follows: $\sqrt{\delta_1[n_b - (\delta - 1)\eta n]}$, where δ_1 is the secondary emission ratio of the first dynode. Although additional contributions are present at the other dynodes, ordinarily they are insignificant.

Addition of all these noise contributions requires that, at each point where there is gain, all the preceding signal and noise be multiplied by the gain factor, that is, $\delta - 1$ at the target and δ_1 at the first dynode. It is convenient, however, to consider all noise contributions, as numbers of photoelectrons passing through the mesh. Therefore, instead of multiplying the preceding signal and noise by the appropriate gain factor, the succeeding noise and signal are divided by the gain factor or factors to obtain the following photocathode noise equivalents:

Photoelectron Noise $\sqrt{\eta n}$

Equivalent of Target secondary emission noise $\dfrac{\sqrt{\delta \eta n}}{\delta - 1}$

Equivalent of Return beam noise $\dfrac{\sqrt{n_b}}{\delta - 1}$

Equivalent of First dynode secondary emission noise $\dfrac{\sqrt{\delta_1\,[n_b - (\delta - 1)\eta n]}}{\delta_1\,(\delta - 1)}$

Because noise adds in quadrature, the square root of the sum of the squares of these four terms is the total equivalent tube noise; the signal at this point (passing through the mesh) is ηn. Thus, the signal-to-noise ratio R for the whole tube is given by

$$R = \frac{\eta n}{\sqrt{\eta n\left[1 + \dfrac{\delta}{(\delta - 1)^2} - \dfrac{1}{\delta_1\,(\delta - 1)}\right] + n_b\left[\dfrac{1}{(\delta - 1)^2} + \dfrac{1}{\delta_1(\delta - 1)^2}\right]}} \quad (3)$$

II. Highlight Signal-to-Noise Ratio

The beam is ordinarily adjusted so that highlight signals are just discharged. Even under this condition, some incident beam electrons are scattered back into the return beam. A modulation factor m, which is the ratio of charge deposited on the target to total incident beam at the point of just discharging, may be measured. The subscript zero refers to the highlight value, and n_0 is the number of photoelectrons emitted for a *highlight* element. The factor m is defined as follows:

$$m = \frac{(\delta - 1)\eta n_0}{n_b}$$

When this factor is used to eliminate n_b, the highlight signal-to-noise ratio R_0 is given by

$$R_0 = \frac{\sqrt{n_0}}{\sqrt{\dfrac{1}{\eta}\left[1 + \dfrac{\delta}{(\delta - 1)^2} + \dfrac{1}{m(\delta - 1)} + \dfrac{1 - m}{m\delta_1(\delta - 1)}\right]}}$$

If the following dimensionless quantity:

$$\frac{1}{\eta}\left[1 + \frac{\delta}{(\delta - 1)^2} + \frac{1}{m(\delta - 1)} + \frac{1 - m}{m\delta_1(\delta - 1)}\right]$$

is assigned the symbol F, then the preceding equation becomes

$$n_0 = R_0^2 F \quad (1)$$

The number n_0 may be obtained from the bandwidth B of the electrical transmission system and the frame time t: The number of elements which the electrical system can transmit per second is $2B$. If α is the fraction of the time the system is unblanked and actively scanning (α is usually about 0.81), there are $2Bat$ elements in a frame. If the photocathode is uniformly illuminated with I (ft-c) over its active area A (sq ft), and if the photocathode has a sensitivity of S (amp/lm), the average photocathode current is IAS and the number of electrons emitted per frame time is IAS/e; e is the electron charge (coulombs).

The number n of electrons emitted per element per frame time is given by

$$n = \frac{IAS}{2eB\alpha} \quad (4)$$

Thus equation (1) becomes

$$\frac{I_0 AS}{2eB\alpha} = R_0^2 F \quad (2)$$

where I_0 is the highlight illumination.

III. Lowlight Signal-to-Noise Ratio

The signal-to-noise ratio as a function of light level within a given scene: Within a given scene, the beam current is constant and determined by the highest light level I_0 which the beam must discharge and the modulation factor m. The signal-to-noise ratio may be obtained as a function of light level by substituting the following values in Eq. (3) of Appendix I:

$$n = IAS/2eB\alpha$$

$$n_b = \frac{n_0\eta(\delta - 1)}{m} = \frac{I_0 AS\eta(\delta - 1)}{2eB\alpha m}$$

If the equation so obtained is divided

by Eq. (1), then the dimensionless ratio R/R_0 is obtained as a function of the dimensionless ratio I/I_0, as follows:

In other words, this gives the relative signal-to-noise ratio as a function of the relative illumination.

$$\frac{R}{R_0} = \sqrt{\frac{\frac{I}{I_0}\left[1 + \frac{\delta}{(\delta-1)^2} + \frac{1}{m(\delta-1)} + \frac{1-m}{m\delta_1(\delta-1)}\right]}{\left[1 + \frac{\delta}{(\delta-1)^2} - \frac{1}{\delta_1(\delta-1)}\right] + \frac{I_0}{Im}\left[\frac{1}{(\delta-1)} + \frac{1}{\delta_1(\delta-1)}\right]}} \qquad (5)$$

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A Fifty-Millimicrosecond Flash X-Ray System for High-Speed Radiographs

By F. J. GRUNDHAUSER, W. P. DYKE and S. D. BENNETT

The recently developed temperature-and-field emitter is useful in applications requiring both high resolution and high speed. The cathode has been applied to a family of new x-ray tubes operating at currents and voltages up to 2000 amp and 600 kv, respectively. Earlier tubes, operating at a pulse length of 0.2 μsec, provide radiographs with good resolution through as much as eight inches of aluminum in a single pulse.

The extension of these techniques to a pulse length of 50 mμsec is described. Resolution and film density are sufficient for a number of hypervelocity mechanisms. The performance of the tube and x-ray system is described.

A NUMBER OF HIGH-SPEED mechanisms occurring during detonation, fragmentation, acceleration, etc., are not recordable through visual photography either because the object is opaque or because the event under study is itself an intense source of light. X-rays can be used to penetrate and detect changes in density, shape, etc., in such cases.

Mechanisms involving velocities of a few millimeters per microsecond, e.g., detonation and shock waves, require exposure times of a few tenths of a microsecond and, therefore, electron currents in the x-ray tube of the order of 1000 amp, assuming presently available films and intensifying screens. It is possible to draw such currents from a vacuum arc in which a plasma is formed at the expense of vaporized electrode material. This principle has been applied to a vacuum arc x-ray tube[1] which has been extensively used in ballistic studies. Anode configurations of such tubes have recently been changed to improve optical resolution.[2] In Russia the arc tube has been extended to higher voltage (1.5 Mev) to provide 0.15 microsecond exposures through 2.8 in. of steel at a film-to-source distance of 20 in.[3] More recently a gas-filled x-ray tube has been used with microsecond exposures at 600 kv through 2 in. of steel.[4] Two vacuum arc tubes have been pulsed simultaneously to provide stereoscopic views.[5]

At hypervelocities, e.g., 50,000 ft/sec, x-ray exposures of the order of 10^{-8} sec or shorter, are desired in order to minimize motion blur. Correspondingly, the electron current in the x-ray tube must be of the order of 10^4 amp with present films and screens, and with a film-to-source distance of a few feet. At the same time, adequate optical resolution requires a beam cross section at the anode (x-ray source size) no larger than 1 cm and preferably of the order of 1 mm. Hence the required electron current density J_a at the anode lies in the range $10^4 < J_a < 10^6$ amp/sq cm when the x-ray tube is to be used to record mechanisms at hypervelocities.

Recent work[6] reveals a rise time of the order of 10^{-8} sec for vacuum arc current; however, other studies[7] seem to indicate that further work would be required to develop the arc cathode into a reliable, reproducible long-lived electron source at pulse lengths of the order of 10^{-8} sec.

For a number of reasons a controlled source is desired in which electron current is in phase with voltage in order to (1) maximize x-ray yield while minimizing stored energy, cost and anode heating; (2) optimize and facilitate the measurement of x-ray spectrum as needed to relate observed photographic densities to the densities of the media under study; (3) maximize both optical resolution (minimize x-ray source size) and tube life (avoid excessive anode heating); (4) provide reproducible x-ray intensity on a pulse-to-pulse basis as needed in sequential radiographs, quantitative studies, etc.; and (5) insure reliability in order to avoid the expense and delay of data lost by tube failure.

These requirements are met by the newly practical field emission electron source. The basic properties of such cathodes, and their initial application to a microsecond x-ray tube have been reviewed in a recent publication.[8]

The present paper reports the utilization of the field emission cathode in a flash x-ray tube and system which provide a radiographic exposure in 50 mμsec. Design and performance of these equipments are discussed including such parameters as penetration, resolution, etc.

X-Ray Tube Design and Performance

As was mentioned above, radiographic exposure times of the order of 10^{-8} sec require electron current densities at the anode in the range 10^4 to 10^6 amp/sq cm.

Presented on October 18, 1960, at the Fifth International Congress on High-Speed Photography by F. J. Grundhauser, W. P. Dyke (who read the paper) and S. D. Bennett, Field Emission Corp., 611 Third Street McMinnville, Oregon.

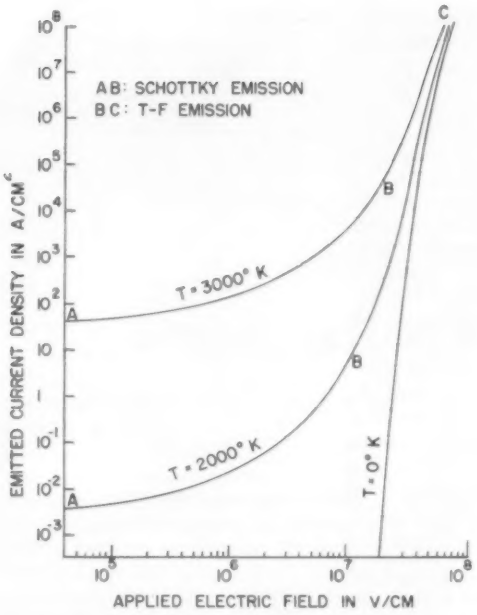

Fig. 1. Graph showing electron current density emitted from tungsten in vacuum as a function of temperature and electric field: (A) thermal emission; (B) T-F emission; (C) field emission.

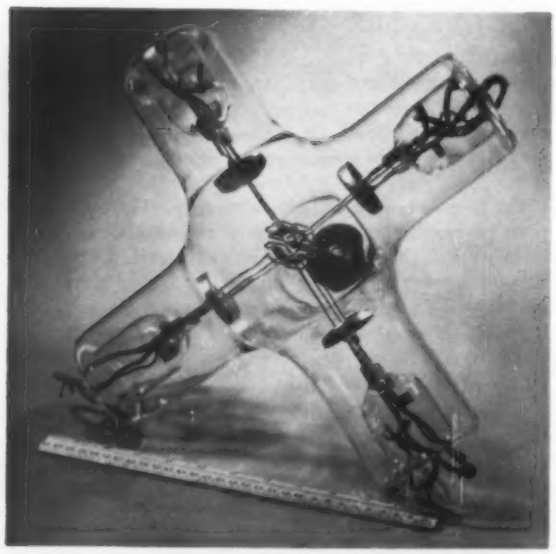

Fig. 3. Photograph of experimental T-F emission x-ray tube used in present experiments at 0.05 μsec. Principle is similar to that in Fig. 2 except that cathode configuration is cylindrical and anode is a solid tungsten cone.

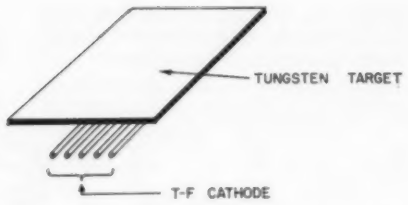

Fig. 2. Schematic drawing of T-F emission x-ray tube showing tungsten wire cathodes (10-15 mils) and plane tungsten anode; typical electrode spacing 5 to 10mm.

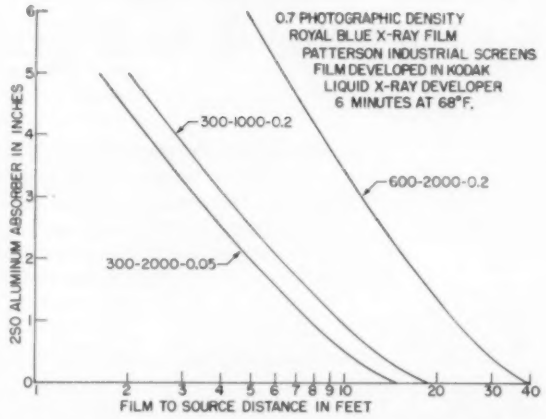

Fig. 4. Graph showing the thickness of aluminum absorber versus film-to-source distance for several values of current, voltage and pulse length. A photographic density of 0.7 and commercial film-screen combination were used.

The properties of an electron beam are closely related to the characteristics of the electron source. Thermal emission cathodes used in conventional x-ray tubes yield current densities of the order of 10 amp/sq cm, e.g., at *A*, Fig. 1. Thus a current of 10^4 amp requires an emitting area of the order of 10^3 sq cm; in this case, a beam cross section of 1 sq cm at the anode requires an area compression of 10^3:1. Such compression presents difficult electron optical problems and the energy required to heat the cathode is large. This approach does not lend itself to a small, low-cost, expendable x-ray tube needed in many hypervelocity experiments.

As the electric field at the cathode surface is raised, the emitted electron current density increases rapidly; and the size, heat energy and cost of the corresponding cathode structure correspondingly decrease. With tungsten, a field of a few million volts/cm and a temperature in the range 2700 to 3000 K yield current densities of the order of 1000 amp/sq cm; this case, indicated at *B*, Fig. 1, is called T-F emission[9] since current density depends on both temperature (*T*) and electric field (*F*). Under these conditions, and with an applied voltage of 300 kv, a typical cathode embodiment is a group of tungsten wires of diameter 10–15 mils and total length a few centimeters. A schematic of a planar electrode T-F emission x-ray tube, which we have called Fexitron, is shown in Fig. 2. A photograph of an experimental model tube is shown in Fig. 3. In the latter, the emitting cathode area is 1 sq cm, the electron current density at the anode is 2000 amp/sq cm and the perveance is 12×10^{-6} amp/volt$^{3/2}$. At 300 kv, 2000 amp, the peak power is 600 megawatts; the beam is generated, focused and dissipated in a volume of approximately 1 cc. Field emission techniques, e.g., clean surfaces and a vacuum of 10^{-12} mm of Hg are used both to provide high current density and to prevent voltage breakdown in the small tube structure. The tube anode, a tungsten cone, changes from room temperature to 3000 K in

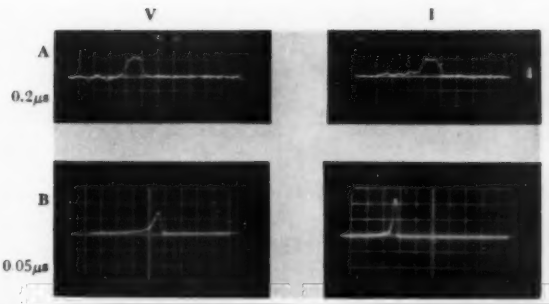

Fig. 5. Current and voltage waveforms for two Fexitron equipments: At (A), 600 kv, 2000 amp, 0.2 μsec using coaxial cable storage, and; at (B), 300 kv, 2000 amp, 0.05 μsec using lumped constant lines.

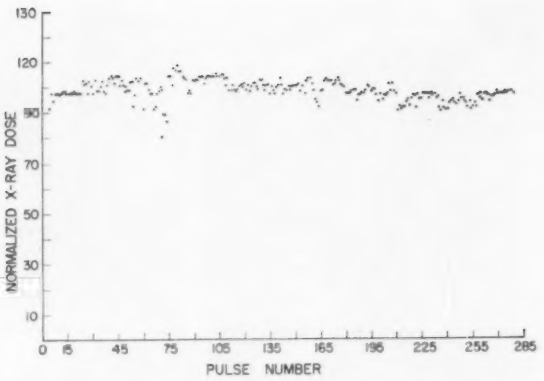

Fig. 6. Graph of normalized x-ray dose illustrating reliability of a standard production Fexitron x-ray tube No. 301, Type T-300-1000-0.2 at full power: 300 kv, 1000 amp, 0.2 μsec. Graph hows typical 280 pulse sequence from longer total life; dose read on Cambridge dosimeter No. 214410 at beam direction of maximum intensity vs spot size.

0.05 μsec. The target cone has a base diameter of 2.5 mm and a cone angle of 7°. When x-rays are extracted along the conical axis, it provides an apparent x-ray source size of 2.5 mm.

Of particular interest is the thickness of absorber which x-rays of a given intensity and wavelength can penetrate at a given film-to-source distance. The penetration through 2SO aluminum provided by Fexitron tubes is shown in Fig. 4. For the experimental 0.05 μsec x-ray tube mentioned above, the penetration is 1.5 in. of aluminum at 6 ft.

With T-F emission, current responds instantaneously to voltage so that a square voltage pulse can be made to give a square current wave which is in phase with the voltage. The advantages of such wave relationships were noted earlier. The waveshapes obtained with Fexitron equipments are shown in Fig. 5 at pulse lengths of both 0.2 and 0.05 μsec. The indicated rise time is approximately 3×10^{-8} sec.

Also, in the case of T-F emission, the cathode is conserved, and both the tube current and x-ray dose are reproducible on a pulse-to-pulse basis as is shown in Fig. 6. These data may be compared with the observations of Flynn[7] in which the arc current rise time was of the order of 10^{-6} sec, current and voltage were out of phase, and reproducibility of dose and waveform were difficult, presumably due to the explosive character of the vacuum arc process.

In certain hypervelocity studies, for example concerning the effects of meteorite impact on satellites, the ability to resolve very small particles is essential. Three conditions must be satisfied. First, the x-ray pulse length must be short enough to avoid motion blur. The relationship between velocity, particle size, and required pulse length is shown in Fig. 7. For example, assuming a pulse length of 0.05 μsec and an allowable blur of half the particle diameter, a 1-mm particle can be resolved at velocities up to 30,000 ft/sec.

The second condition is that the particle must absorb enough radiation to cause a detectable change in film density. The particle thickness which can be resolved for various materials and x-ray wavelengths (beam voltages) is shown in Fig. 8, assuming that the particle absorbs 10% of the incident radiation. For example, lead particles as thin as 1 micron can be resolved at a beam voltage of 50 kv.

The third factor influencing resolution is the x-ray source size and the other geometric arrangements used in the experiment. Let f be the source size, O the object

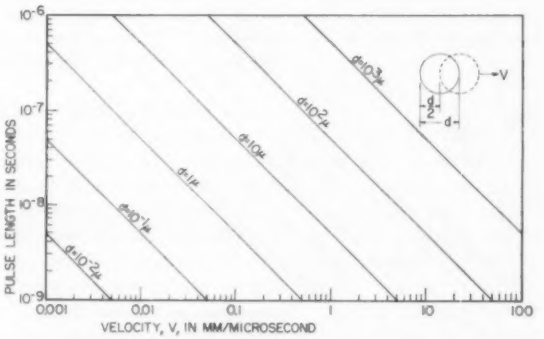

Fig. 7. Graph showing flash x-ray pulse width vs. particle velocity for specified velocity resolution d/2; particle size 1000 micron to 0.01 micron.

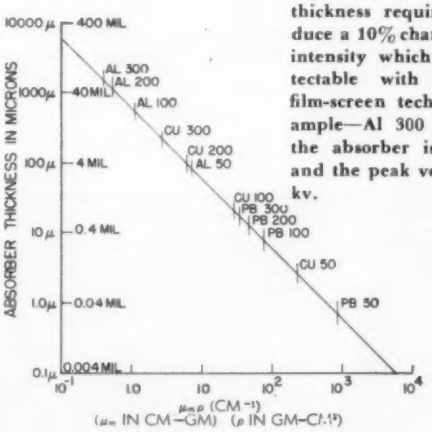

Fig. 8. Graph of material thickness required to produce a 10% change in x-ray intensity which is just detectable with commercial film-screen technology. Example—Al 300 means that the absorber is aluminum and the peak voltage is 300 kv.

size, F the image size, b the object-to-film distance, a the film-to-source distance, and O_e the penumbra due to the finite source size, as in Fig. 9. Then

$$O_e = \frac{fb}{a - b}$$

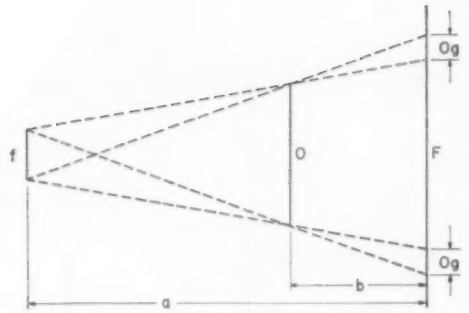

Fig. 9. Drawing showing the geometrical arrangement of x-ray source f, object O, and image F; blur O_g is caused by finite source size; film-to-source distance is a; film-to-object distance is b.

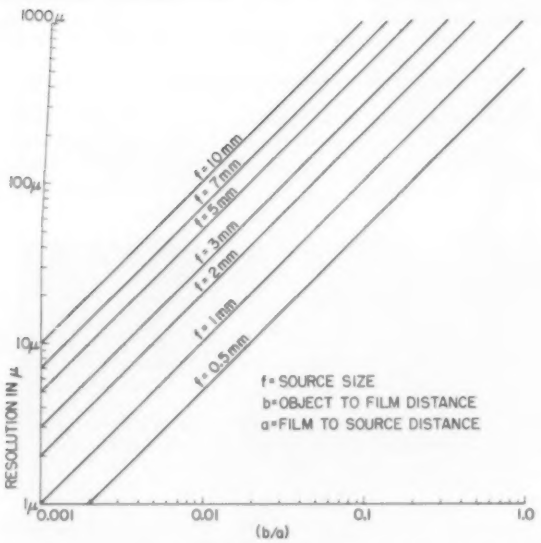

Fig. 10. Geometrical resolution vs. ratio of object-to-film distance/film-to-source distance, (b/a), for x-ray source sizes ranging from 0.5mm to 10mm.

and in terms of the magnification $V = \frac{a}{a-b}$

$$O_g = (V-1)f. \tag{1}$$

The resolution is then

$$R = \frac{O_g}{V} = \frac{(V-1)}{V} f = \frac{b}{a} f \tag{2}$$

The resolution R in Eq. (2) indicates the smallest spacing that two objects can have without overlapping penumbra. A graph of R vs. b/a is shown in Fig. 10. Values of $b/a < 10^{-2}$ are often useful with small particles, assuming some care with film protection. In this case, and with $f = 2.5$ mm for the x-ray source size in the present experimental tube, particles as small as 25 microns (1 mil) can be resolved.

The high resolution attainable with the present x-ray system can be seen in radiographs of an exploding cap shown in Fig. 11. Velocities up to 5 mm/μsec and particle sizes down to 175 microns (7 mil) are clearly resolved in accord with the predictions of Figs. 7 and 10 respectively. Also, the contrast predicted in Fig. 8 is observed experimentally since fragments of the 7-mil copper wall are resolved and the beam voltage was 300 kv.

X-Ray Pulser and System

The x-ray system used with the foregoing tube consists of a pulser (1), a 30-kv d-c supply (2), a source of dry nitrogen at variable pressure (3), a filament step timer (4) and a trigger amplifier (5). This system is shown in Fig. 12.

The pulser forms the voltage wave shown in Fig. 5 with a peak voltage of 300 kv and a current of 2000 amp. It is a twenty-four stage Marx surge circuit using spark gaps and plug-in storage units. The latter are housed in the pressure caps visible at the sides of the pulser and can be removed and replaced in order to change pulse length, impedance, or output voltage. All conductors are either potted in solid dielectric (epoxy resin) or pressurized in dry nitrogen; the spark gaps and storage elements are also enclosed and pressurized. In this way the pulser performance is isolated from such atmospheric variables as dust, humidity, pressure, etc. Output voltage is varied by simultaneously adjusting the charging voltage and nitrogen pressure. Output voltage may thus be varied by remote control from 50 kv to 300 kv at a constant impedance of 150 ohms. The spark gaps are usually operated with fixed spacing; however, they may be adjusted, for example, to extend the voltage

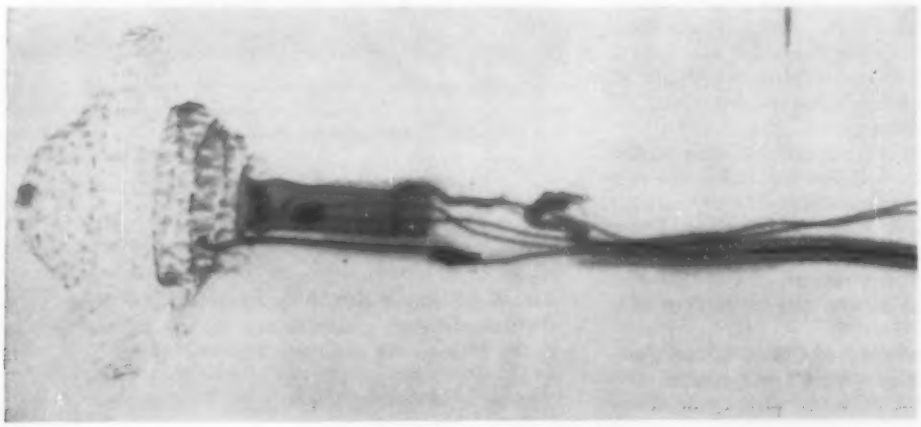

Fig. 11. Radiograph of commercial blasting cap taken with Fexitron PS-300-2000-0.05. Film-to-source distance 72 in.; object-to-film distance 1.5 in. Blasting cap wall thickness 7 mil copper. Radial velocity of fragments approximately 16,000 ft/sec.

Fig. 12. Photograph showing 300 kv single channel portable Fexitron x-ray system including: (1) pulser; (2) 30 kv d-c power supply; (3) pressure gauge and regulator; (4) filament step timer; (5) trigger amplifier.

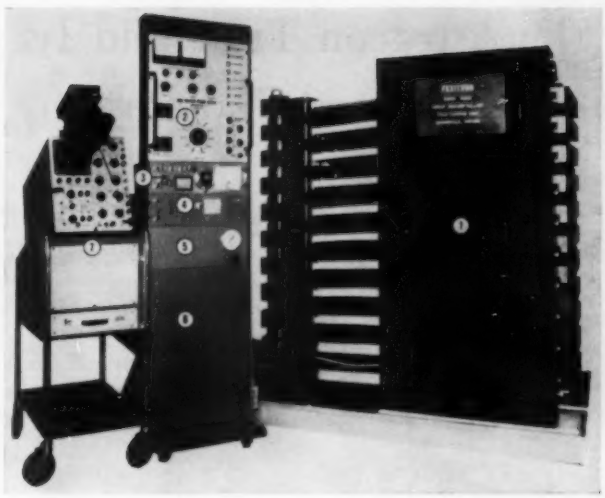

Fig. 13. 1200 megawatt Fexitron x-ray system: A typical single channel 600 kv, 2000 amp, 0.2 μsec flash x-ray system showing arrangement of: (1) 600 kv pulser, (2) 120 kv d-c charging voltage control panel, (3) Sequential timer, (4) Trigger amplifier, (5) Nitrogen pressure control panel, (6) Power supply, 120 kv, H. V. section, and (7) Oscilloscope for wave-form monitoring.

beyond the range quoted, or removed for cleaning. The tube may be operated remote from the pulser when the two are connected to opposite ends of a 300-ohm transmission line, for example, a twin-ax comprising two stripped RG-19 cables. In this manner, the tube may be sacrificed if necessary in ballistic studies while the pulser and other electronic gear are isolated from the blast. By use of solid dielectric and barium titanate storage, the pulser size and weight are minimized. It consists of an 8-in. cylinder 54 in. high; the caps extend 15 in. tip-to-tip. The pulser weighs approximately 115 lb. As was mentioned earlier, the rise time of the voltage wave is 2×10^{-8} sec, and of the x-ray pulse, 1×10^{-8} sec as measured by a photoelectric detector and travelling wave oscilloscope.

The tube filaments are operated at a relatively high temperature (2700–3000 K); hence in order to minimize evaporation, the filament heating time is limited by a timer (4) comprising a telechron drive, cams and microswitches. The filament temperature is raised in three steps in order to control thermal shock. This timer may also be used to initiate other equipments or mechanisms under study.

The trigger amplifier (5) accepts a signal in the range 10 to 100 v and amplifies it to a level sufficient to break down the first spark gap in the pulser.

In the present state of the art, multiple radiographs of the same high-speed event require multiple pulsers and tubes. A three-channel system has been operated successfully to obtain three radiographs at intervals of one microsecond or greater. Two channels will provide stereographic views.

600-kv X-Ray System

When x-ray penetration or dose rate are critical, a higher voltage may be utilized. The same general techniques that were described above have been employed in a 600-kv, 2000-amp (1.2 billion watt) system which will give unit film density through 6 in. of aluminum in 0.2 μsec. A photograph of the system is shown in Fig. 13; its performance is indicated in Fig. 4.

The gamma dose rate at the surface of the 600-kv x-ray tube used with this system is 10^8 R/sec. With possible modifications to decrease the source-to-sample distance, a dose rate of 10^9 R/sec appears feasible. Attention is called to the possible use of this equipment in studies of radiation effects and damage, both because of the unusually high dose rate and because it provides a pure gamma source free from neutrons. As a future possibility, it appears that a thin window can be used to extract the electron beam for direct exposure of the sample. In this case, dose rates up to 10^{12} R/sec are expected when a conservative current density is assumed in order to maintain an acceptable window temperature.

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The Astracon Tube and Its Application to High-Speed Photography

By A. E. ANDERSON, G. W. GOETZE and H. KANTER

In high-speed and ultra-high-speed photography, cameras utilizing single-stage electronic image-converter tubes have proved to be very useful. These electronic cameras however, have the disadvantage of small light gain, so that a high brightness of the primary image is required. The use of a multistage image-intensifier tube, such as the Astracon, overcomes this difficulty.

A high-speed camera of "ultimate light gain," employing two Astracon tubes, has been built. With this camera, it is possible to record single photoelectron events on photographic film. The performance of this camera is discussed as a specific application of the Astracon tube in high-speed photography at extremely low light levels.

SINGLE-STAGE electronic image converters have been widely used as fast-acting shutters in high-speed photography. Image converters of this type provide some signal amplification. However, internal noise problems limit the practial output/input light gain of such tubes to about 100. When losses introduced in coupling the output of the converter to photographic film are included, the system gain is very often 10 or less. In many cases, this gain is not sufficient to permit photographic recording of high-speed events because of signal limitations which result from the short exposure or the small light output from the event of interest. Recently, at least two types of multistage image intensifiers[1-3] have been successfully employed in fast-acting cameras to record images at extremely low light levels. Signals due to single photoelectrons leaving the photocathode of the intensifier have been photographed. These cameras have sufficient gain to permit recording all the information available in low-density electron images and therefore in this sense may be said to possess ultimate gain.

In this paper, we briefly describe the Astracon (WX-4342), a multistage image intensifier of ultimate gain which has been developed at the Westinghouse Research Laboratories, and we present data relating to its performance in high-speed photography.

Description of the Tube

Figure 1 shows the basic geometrical arrangement of the Astracon. A photosurface, four plane parallel thin films and a phosphor screen are enclosed in a vacuum envelope. The thin films act as dynodes which multiply the photoelectric current as in a conventional photomultiplier. The current to be amplified falls on one side of the dynode and the secondary current is released from the opposite side.

The number of secondary electrons released on the average by one incident electron is defined as the yield, which depends for a given film on the accelerating voltage. For the dynodes used in the Astracon, the yield is 5 to 6 at 4 kv. The electrons released from the last dynode are accelerated by 15 kv to the phosphor which transforms the amplified electrical current into an optical signal.

Under these conditions, the overall photon gain of the present tubes is 5000 to 10,000. Focusing is obtained by an axial magnetic field of about 500 gauss. Limiting resolution is 12 line pairs/mm over 25 mm. Gating of the tube has been accomplished by pulsing the operating voltage of the photocathode/first dynode stage. The interstage capacitance of the tube is 15 $\mu\mu$f. In order to meet specific experimental requirements which will be explained later, we have gated the Astracon with pulses of 10^{-8} sec duration. Gating times shorter than 10^{-6} sec are believed possible with suitable pulse circuitry.

In order to achieve the lowest possible dark current, it is desirable to operate the photocathode at ground potential since this minimizes the possibility of corona discharges in the neighborhood of the cathode which can give rise to additional dark current.

The Nuclear Track Camera

Figure 2 is a block diagram of a nuclear track camera, using two Astracon tubes, which has been constructed and operated at our laboratory. In this camera, light produced along the path of a particle traversing a scintillation crystal is imaged by a mirror system onto the photocathode of the first intensifier. The output of the first intensifier is optically coupled to the second intensifier by a standard lens pair in a front-to-front arrangement (2 Zeiss Biotar lenses, 75 mm, $f/1.5$). Whenever a

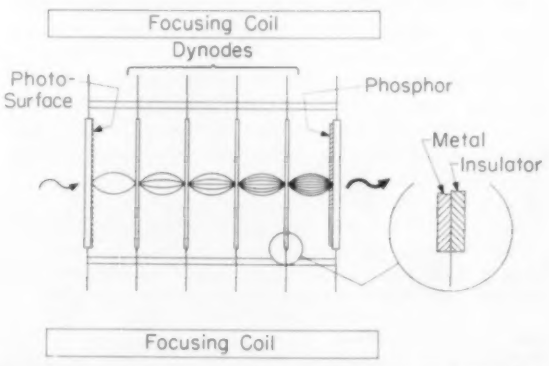

Fig. 1. Schematic of transmission secondary emission intensifier.

Presented on October 18, 1960, at the Fifth International Congress on High-Speed Photography in Washington, D.C., by A. E. Anderson (who read the paper), G. W. Goetze and H. Kanter, Physics Project Laboratory, Westinghouse Research Laboratories, Beulah Rd., Churchill Borough, Pittsburgh 35, Pa.

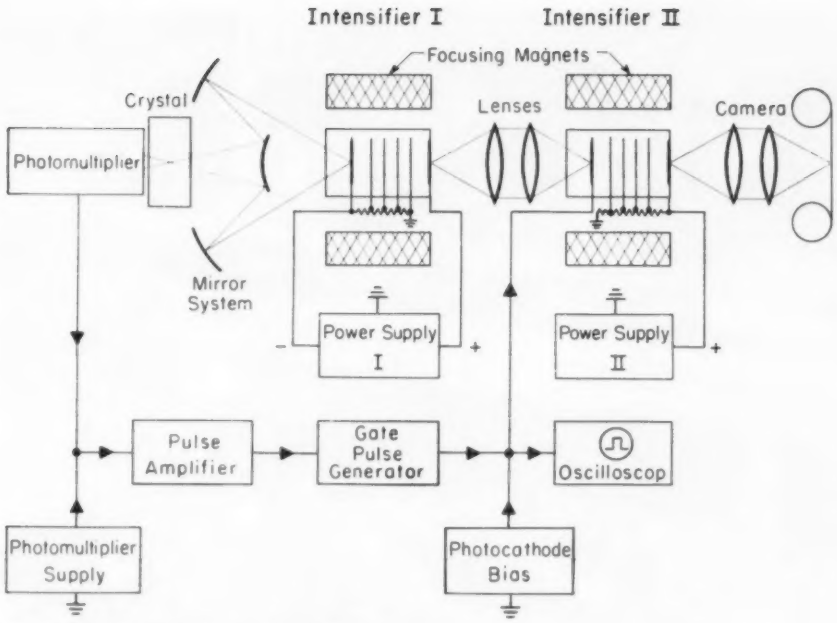

Fig. 2. Block diagram of image-intensifier system.

Fig. 3. Track pictures of cosmic-ray particles

desired event occurs in the crystal, the second intensifier is operated for a short time interval. In the particular experiment described, a photomultiplier in optical contact with the crystal triggers a pulse generator which then delivers a gate pulse to the second intensifier.* During the gate time, the track image that appears on the output of the first tube is further intensified by the second tube in order to record it on photographic film. The phosphor of the first tube must be designed to store the information long enough to permit operation of the gate circuit. The gate time is made somewhat longer than the decay time of the phosphor to utilize the full light emission of this phosphor. Since tubes with a type P-11 (ZnS:Ag) phosphor were used, the gate time was chosen to be 1 msec. An Exakta camera is used to record the output of the second intensifier on Ansco Super-Hypan film.

Light flashes due to single electrons released at the first photocathode were readily recorded as bright spots on the film. The fact that these flashes actually represent single photoelectrons was verified as follows. The output dark current of the first tube was measured and divided by the known electron gain. The calculated photocathode dark current was compared with the observed flash population on the output screen and was found to agree within a factor of 1.5.

The number of recorded photoelectron events per centimeter of track image can be estimated from the number of photons emitted per centimeter of track in the scintillation crystal, the light collection of the input optics, and the photocathode efficiency of the first tube. The geometric light collection of the front optics can be calculated using the approximate relation

$$L \sim [16Q^2n^2(1 + M)^2]^{-1}$$

where Q is the f-number of the front optics (focal length/lens diameter), n is the index of refraction of the scintillator and M is the minification ratio. An $f/1.2$ mirror was used instead of a lens to avoid the light losses due to absorption. The minification used was 2, and the index of refraction of the sodium iodide crystal is 1.78. Therefore, the light collection of the input optics was calculated to be 1.5×10^{-3}. With an emission of 10^5 photons/cm of track for a minimum ionizing particle in a NaI (Tl)-crystal, it follows that only 300 photons/cm of the image of the track arrive at the photocathode of the first tube. The quantum efficiency of the photocathode for the blue light emitted by the crystal could not be determined accurately, but was estimated to be about 5%. One should therefore expect of the order of 15 photoelectrons/cm of track image to be released at the photocathode. Actual track pictures of cosmic-ray particles obtained with this system (see Fig. 3) show about 7 dots/cm, in reasonable agreement with the calculated value.

Well focused track pictures appearing as a straight line of dots, such as reproduced in the upper frame of Fig. 3, can be expected only if the particle track stays within the focal plane of the front optics. Whenever the track lies outside the focal plane, a "blurred" image appears, consisting of dots distributed over a certain band rather than along a straight line (lower frame of Fig. 3). The useful volume for a well-focused image depends on the acceptance angle of the input optics. A larger depth of focus is feasible only with a sacrifice in light collection. The limited depth of focus represents a certain serious disadvantage in most applications. This limitation may be overcome by the use of scintillators consisting of plastic fibers.[4]

In such crystals, the light produced anywhere along the length of the fiber is piped to the end-face so that a lens with shallow depth of focus can be used. When the area of the crystal end-face is not too large, and greater

*In more refined experiments, the monitoring photomultiplier would be replaced by a suitable coincidence-counter arrangement.

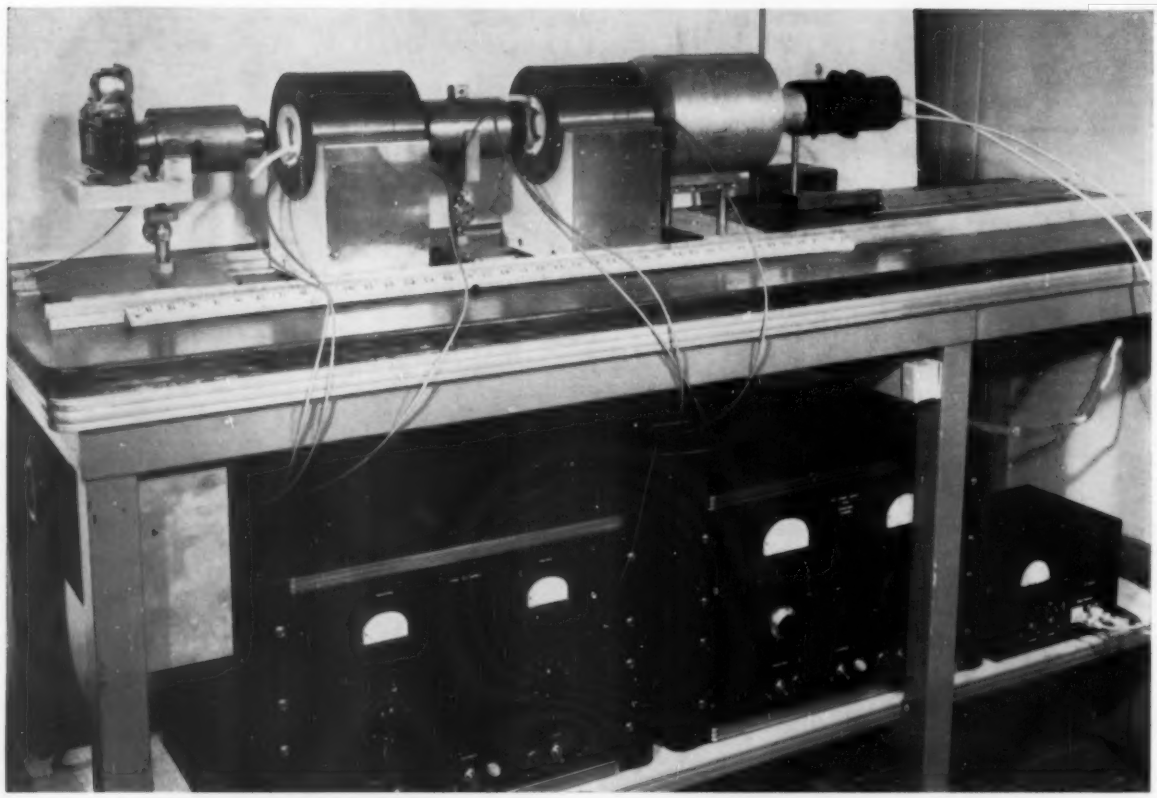

Fig. 4. General view of image-intensifier system.

light collection is desired, the fibers may be brought into direct contact with the photocathode of the image intensifier by the use of a vacuum-tight glass-fiber input window.†

A general view of the whole camera system is shown in Fig. 4. The length of the system is about 1 m, the width 25 cm and the height 30 cm. Once the magnetic field and the individual dynode voltages have been adjusted to achieve optimum focusing, readjustments are made by controlling the operating voltage. The system has been operated successfully over periods of many hours with no noticeable change of focus or overall gain.

Conclusion

It has been demonstrated that multistage image intensifiers of the transmission secondary emission type can be used in high-speed photography at extremely low light levels. These tubes provide ultimate gain, good resolution, low background, minimum image distortion and fast response in a relatively small and convenient package.

†At present, image tubes with glass-fiber input windows 10 cm in diameter are commercially available (Westinghouse Fluorex WX4481).

Acknowledgments

The authors wish to thank D. D. Doughty for his contributions to the experimental phase of the work reported. The support of the U.S. Atomic Energy Commission and the U.S. Army Engineers Corps which led to the development of the tubes used in the nuclear track camera described is also gratefully acknowledged.

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VFK-ÚVOJM High-Speed Framing Camera

By JAN HAMPL

A double-drum, high-speed framing camera capable of photographing fast-moving mechanical and electrical machinery for quantitative analysis produces 1304 pictures, each 5 by 8 mm on a 1850-mm length of unperforated 35mm film. The camera can record at 8000 to 42,000 frames/sec, with an aperture ratio of f/7, and resolves 80 lines/mm. Synchronization of image motion with the moving film is accomplished by rotating an inner drum carrying secondary objective lenses at the speed necessary to cause the image to move at the same velocity as the film on the outer drum.

General Description

The camera was designed and manufactured by the Meopta Optics and Fine Mechanics Research Institute at Přerov, Czechoslovakia, to meet the requirements of some research departments of the Skoda Works, particularly those working on air-blast circuit-breakers, steam turbines, high-speed machining and milling, and material testing problems. This camera ranks among the medium high-speed cameras, with respect to frequency and total number of frames.

Since the customer had not required cine projection but had required a good resolving power of individual frames capable of giving enlarged pictures, the camera was designed as a drum-type apparatus with a rotating film and appropriate photographic objectives. These, totaling 1200 in number, are arranged in a ring of four bands. See Figs. 1 and 2.

A Belar objective (F, 210mm; relative aperture, $f/4.5$) was chosen to operate as main (collimating) objective. In addition, the camera is provided with two supplementary collimating lens systems, one with a focal length of 500 mm for taking pictures at a distance from one meter to ∞ (measured from the front surface of the objective), the other with a focal length of 83 mm for taking macropictures with a magnification as high as 10 × between the entrance stop and the object. This is a high-speed objective with a relative aperture of $f/0.8$.

Presented on October 20, 1960, at the Fifth International Congress on High-Speed Photography in Washington, D.C., by John Waddell for the author Jan Hampl, Meopta Optics and Fine Mechanics Research Inst., Přerov, Czechoslavakia.

The relative aperture of the camera is $f/3.8$. It depends on the relative apertures of the secondary lenses which are laid out in a quadruple circle on the circumference of the drum; but owing to the incorporation of a shuttering stop in the form of a slit on the face of the lens (see Fig. 9 below) it is further reduced to $f/7$ (which, however, is still a considerable speed, where ultrarapid cameras are concerned).

The frames, 5 by 8 mm, are arranged in four bands (Fig. 11). The total number of frames for one run is 1304. Unperforated 35mm cinematographic film strips, 1850 mm in length are used, either black-and-white or color. The resolving power of the system amounts to 80 lines/mm. The pictures can be enlarged without difficulty to 13 by 18 cm, tolerable sharpness being maintained.

The electromagnetic camera shutter is actuated by a special electronic control unit, and is released through this control unit either manually or by an impulse provided by the studied phenomenon itself. The exposure lasts for only one revolution of the film drum. To open the shutter fully and to close it again requires a total of 1.5 millisec. The short duration of the shutter response allows full exploitation of the camera and a maximum number of fully exposed pictures.

At the maximum rate, the exposure of each individual picture lasts no more than 1/42,000 of a second. The object under study, if it has no intrinsic radiation, must be illuminated artificially. Conventional flashtubes, which can also be started off by means of the electronic control unit at the moment of the exposure, can be used to advantage for this purpose. The investigation of powerful electric discharges does not, of course, require

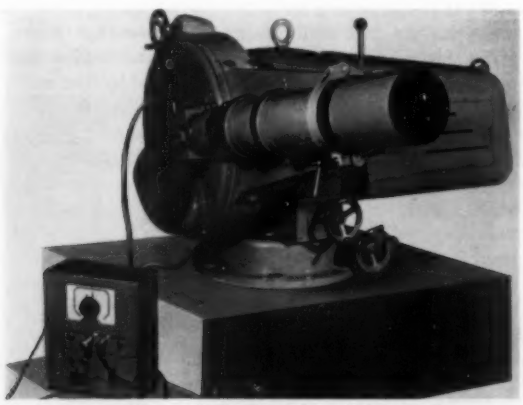
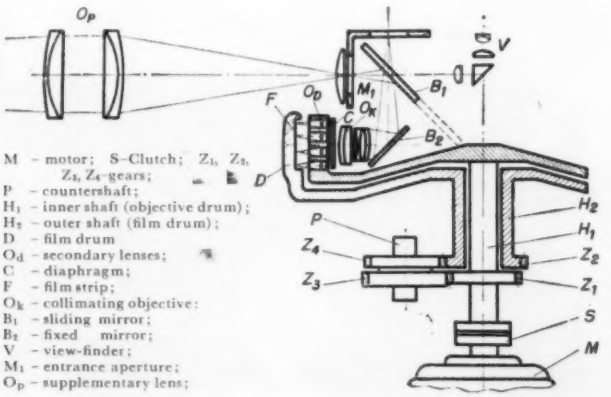


Fig. 1. General layout including triggering unit. Camera shown with a supplementary lens F = 500 mm, and a set of extension tubes.



M – motor; S–Clutch; Z_1, Z_2, Z_3, Z_4–gears;
P – countershaft;
H_1 – inner shaft (objective drum);
H_2 – outer shaft (film drum);
D – film drum
O_d – secondary lenses;
C – diaphragm;
F – film strip;
O_k – collimating objective;
B_1 – sliding mirror;
B_2 – fixed mirror;
V – view-finder;
M_1 – entrance aperture;
O_p – supplementary lens;

Fig. 2. Schematic diagram of optical and mechanical design.

Fig. 3. Loading space of the camera. The magazine is ready for the film to be drawn into the film drum. On the top righthand side can be seen the closed aperture of the auxiliary optical system for lateral shots.

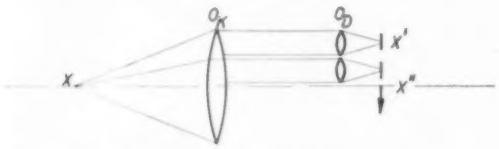


Fig. 4. Principle of optical compensation.

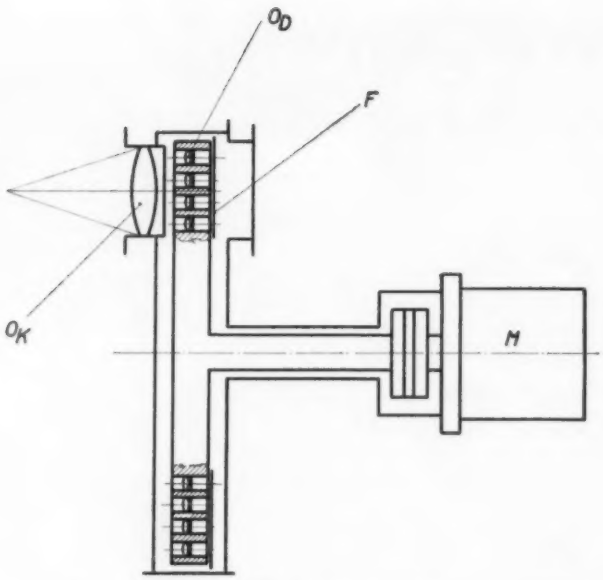


Fig. 5. Schematic drawing of simple disc-shaped high-speed camera working according to the principle shown in Fig. 4.

any additional illumination; sometimes, in fact, the brightness of the phenomenon must be reduced by means of neutral filters.

The camera is driven by a 2.2-kw commutator motor with speed variable from 300 to 2100 rpm. This permits a continuously variable picture rate from 6000 to 42,000 frames/sec, and a total exposure time for the 1304 pictures ranging from 0.2 to 0.031 sec, the latter figure referring to the maximum rate.

Before the shot is taken, the camera rotors are set in motion so as to reach the speed corresponding to the required frame rate. When this rate has been set on the control unit, it is only necessary to wait for the moment suitable for the exposure which — given the correct setting — takes place during one revolution of the film drum. In this way double exposure of the film is prevented.

The camera is movable about the vertical and horizontal axes by two hand-operated wheels. Another hand-operated wheel connected with a friction device for driving the rotors by hand is used for loading the camera.

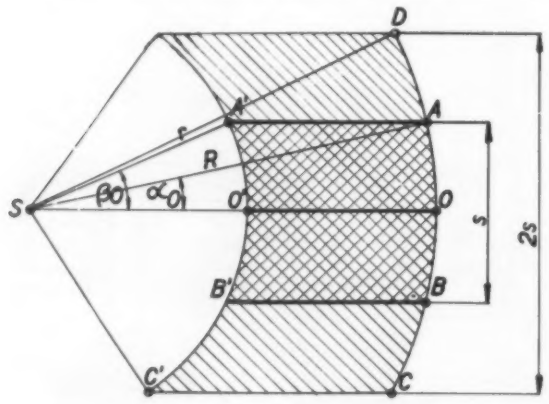


Fig. 6. The condition of image and film synchronization.

The film is put into a specially shaped magazine which allows daylight loading (Fig. 3); the end of the film is gripped in a notch in the drum; and the film is drawn into its bed by manual rotation of the drum. The camera is then ready for shooting. The film is kept in position by centrifugal force. (At maximum speed the acceleration is 1200 g.)

Design Principles

The principle of the optical compensation of the camera is shown in Fig. 4. A stationary object X or its optical image is placed in the focal plane of the main (collimating) objective O_K. The rays emanating from the test object are transformed by the objective into a parallel beam of light. From this beam the secondary lenses O_D pick up their imaging rays. Even if the secondary objectives move across the parallel beam of light, the images X',X'' remain stationary with respect to the (moving) optic axes of these objectives. It is, however, necessary that the optic axes of the objectives O_D be kept parallel with the axis of the main objective O_K. (More generally this requirement applies to the line joining the second principal point of the secondary objective with the frame center.) With a disc-shaped camera and the rays traveling parallel to the disc axis, this would be very easily achieved (Fig. 5). However, the difficulty lies in providing and loading the flat film F in the form of an annulus. For the use of orthodox strip film it is, therefore, necessary to replace this axial principle by the radial solution. Optical compensation is secured here by dividing the system into two drums, one of which (the interior one) carries the secondary objectives O_D while the other (the outer one) carries the film pressed by the centrifugal force into the film bed. If the circumferential velocity of the principal points of the secondary objectives O_D is equal to the velocity of the film surface, then — within certain limits — the above condition for "unblurred" photography is achieved.

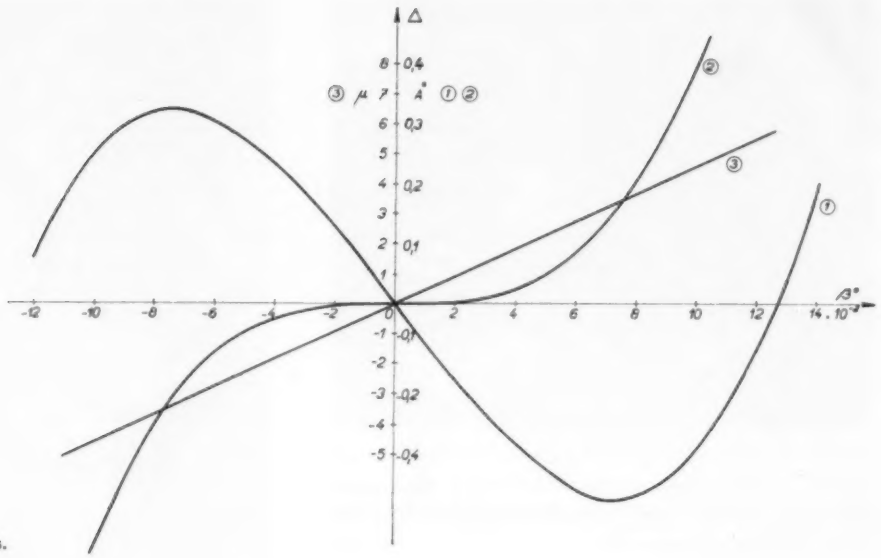


Fig. 7. Aberration analysis.

To prove this, consider a line AA' in Fig. 6 parallel at the moment $t = 0$ to the optic axis of the main objective. The height difference Δ_0 between A and A' is zero. Therefore

$$\Delta_0 \equiv R \sin \alpha_0 - r \sin \beta_0 = 0. \tag{1}$$

Denoting the angular velocities of the radii R,r by $\omega_\alpha, \omega_\beta$, respectively, the height difference Δ of the right-angle triangles at a later moment t is given by

$$\Delta \equiv R \sin \alpha - r \sin \beta = R \sin (\alpha_0 - \omega_\alpha t) - r \sin (\beta_0 - \omega_\beta t), \tag{2}$$

where we assume that the rotation takes place in the negative direction. When the radius vector R is crossing the main optic axis

$$\alpha \equiv \alpha_0 - \omega_\alpha t = 0;$$

$$\text{so that } \Delta = -r \sin \beta = -r \sin \left(\beta_0 - \frac{\omega_\beta}{\omega_\alpha} \alpha_0\right). \tag{3}$$

If now the gear ratio is so designed that

$$i \equiv \frac{\omega_\alpha}{\omega_\beta} = \frac{\alpha_0}{\beta_0}, \tag{4}$$

expression (3) vanishes. For symmetry reasons parallelity is resumed in a situation, denoted in the figure by BB', the parallel positions thus being $(\pm\alpha_0, \pm\beta_0)$, (0,0).

The symbol $(\pm\alpha_0, \pm\beta_0)$ represents parallelity, if according to (1)

$$\frac{\sin \alpha_0}{\sin \beta_0} = \frac{r}{R}. \tag{5}$$

Combining (4) and (5) and denoting $(\sin x)/x \equiv S(x)$, the condition of restored parallelity can be written as

$$\frac{S(\alpha_0)}{S(\beta_0)} = \frac{v_\beta}{v_\alpha}, \tag{6}$$

where v_α, v_β are the circumferential velocities of the radii R,r, respectively.

For small angles α,β the condition (6) reduces to equality of circumferential velocities, as stated above.

However, it is interesting to have a detailed qualitative view of the aberration from parallelity. Choosing in (2), β as the independent variable, one gets

$$\Delta = R \sin i\beta - r \sin \beta = (iR - r)\beta + \frac{1}{6}(r - i^3 R)\beta^3 \tag{7}$$

where the expansion is sufficient for the range of angles under consideration.

Confining ourselves to the vicinity of the condition $i = (r/R)$, where $r<R$, makes the second expansion coefficient positive and the results may be classified according to the sign of the first term.

The curves in Fig. 7 show the three types of cases one can meet in compensating the optical system by adjusting the angular velocities of the two drums. All concern the given camera with $r = 264$, $R = 290$ mm $[(r/R) =$

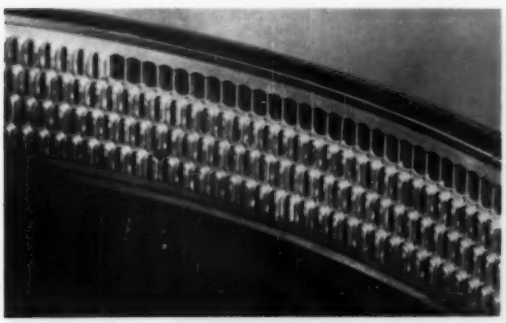


Fig. 8. Circular bank of objectives on the circumference of the inner drum.

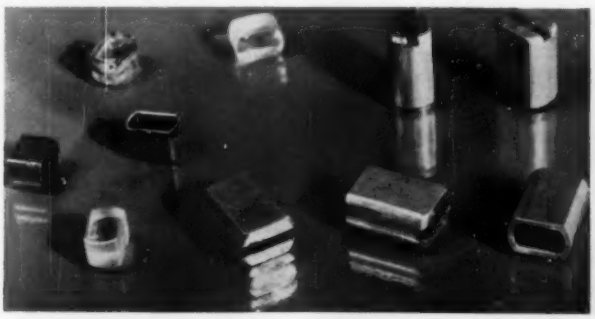


Fig. 9. Secondary objectives, showing shuttering slits.

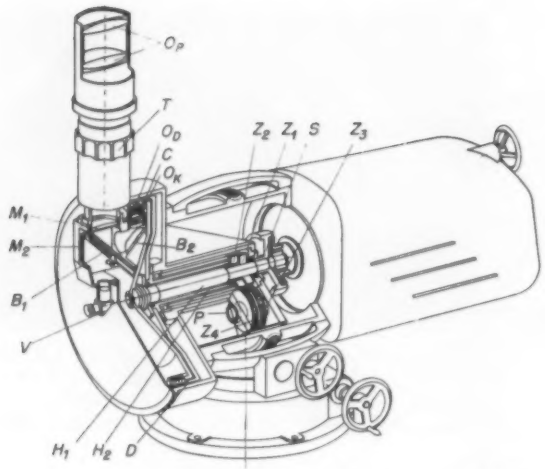


Fig. 10. Cutaway view of the VFK-ÚVOJM High-Speed Camera; T – focusing ring, M_1, M_2 – entrance apertures, other keys as in Fig. 2.

0.9103448] and a field angle 0.16°. Curve 1, displaying three zero points with two relative maxima in between, corresponds to $i = 0.9103447$. The number of decimal digits involved and the order of magnitude of Δ shown in the Fig. 7 render this case purely fictitious as far as mechanics is concerned. The same holds true of curve 2, for which $i = (r/R)$ exactly. These examples are given only to illustrate the qualitative difference between $i \leqslant (r/R)$. Since Δ is then by many orders below the resolving power, there is no practical sense in computing the distribution of blurring across the frame according to the curves 1 and 2, although in other cases the choice of i might prove to be of decisive influence.

Generally it may be stated that the above-mentioned condition of equal circumferential velocities on axis is represented by the curve of the type 2, which means that maximum blurring is at the point furthest from the axis.

Every theoretical gear ratio can of course be realized only within certain limits. In the present camera this ratio is 0.9194000, leading to curve 3, with Δ of the order of microns. Total blurring is equal to twice the maximum positive value of Δ, i.e. in the given case 15 microns, which is just below the resolving power of normal 35mm negative films to be used. Moreover, it should be noted that this maximum blurring is recorded

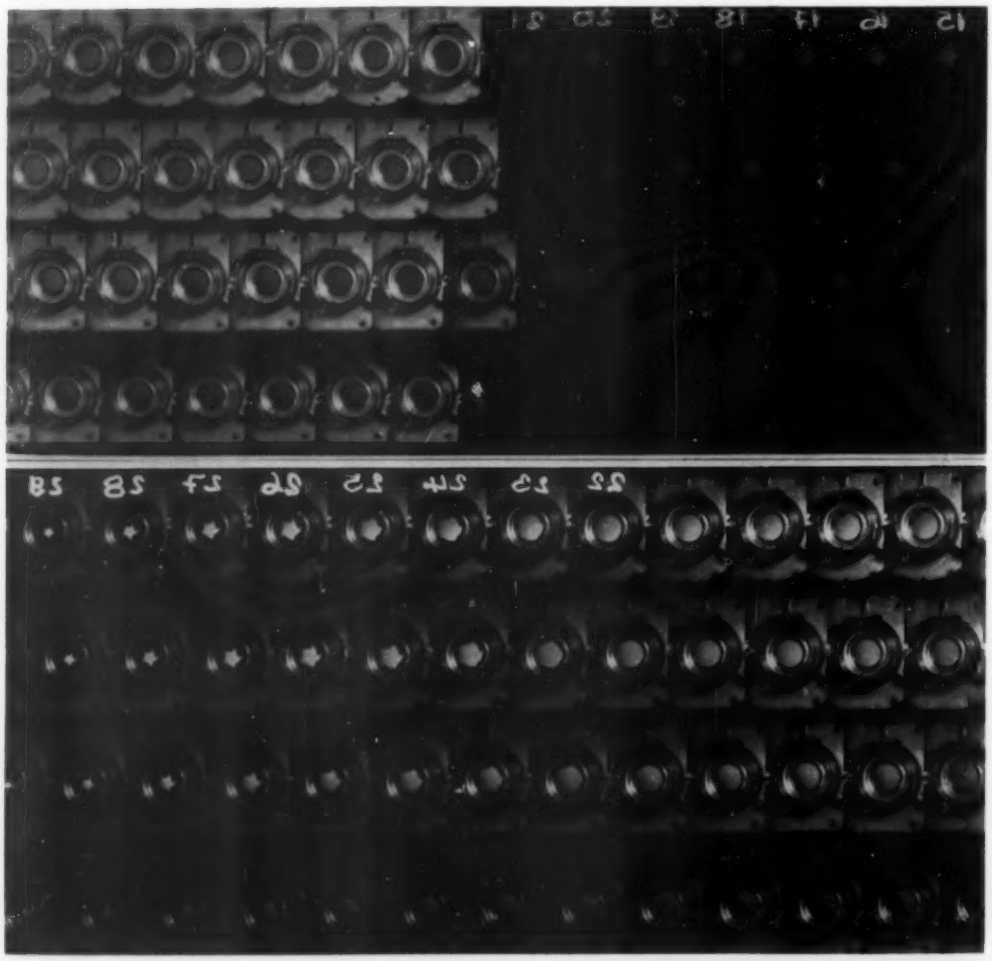


Fig. 11. Example of results obtained in the shutter tests.

Fig. 12. A bulb being broken by a steel ball.

with reduced weight since with equal widths of the main and exposure slits, maximum exposure effectiveness is concentrated near the value $\beta = 0$. Practical tests verified a resolving power of 80 lines/mm, as already stated.

The analysis just given has established the condition of equal circumferential velocities as a reasonable theorem and indicated the tolerance for mechanical construction.

The necessity of satisfying the more general condition (4) would probably occur with small drums carrying relatively large objectives.*

The diaphragm C in Fig. 2 with the exposure slit is arranged in the space between the collimating objective and the secondary objectives. This slit is covered by the plate of the electromagnetically controlled shutter. The plate opens the exposure slit in response to a pulse from the electronic control unit. During the exposure the circle of objectives turns at the gear ratio "i" so that some objectives operate twice during one shot. The number of pictures taken thus increases to 1304. This more effective utilization of the secondary objectives is a further advantage of the indicated solution.

In order to keep the size of the objective drum within reasonable limits the secondary objectives have been

* The idea of moving secondary objectives across a main aperture may be regarded as classical. It has been used in practice, e.g. with the high-speed camera of the French MGD Company (Brit. Pat. 630,912). The optical compensation is there accomplished in the following way: the main objective does not act as a collimator, but it projects the picture into a plane, containing the axis of rotation of the drum. The small secondary objectives had to be mounted with their optic axes intersecting in one common point on the axis of rotation. This seems to complicate manufacture and adjustment. The idea embarked upon in the present work has proved simple to realize and reliable in operation.

Fig. 13. The camera set up to record the operation of a shutter.

arranged stepwise in four staggered bands (Fig. 8). The time sequence of the pictures is such that from the frame in the first band we pass to the second, third and fourth bands, successively, and then for the fifth frame back to the first band, in a position adjacent to the first frame.

In order to achieve a sufficiently short exposure and unblurred images even with high-velocity phenomena, the diaphragm of the secondary objectives is in the form of a rectangular slit (Fig. 9) similar to the main exposure slit.

The isometric drawing in Fig. 10 shows the layout of the rotors in the camera body, as well as the position of the shafts and gears. The inner shaft H_1 is connected with the motor (not visible in the figure) through the clutch S. The outer hollow shaft H_2 is driven from the shaft H_1 through gears Z_1–Z_4.

On the face of the camera a mirror case with the sliding mirror M is shown. The fixed inner mirror M_2 and the collimating objective O_K are also shown. The mirror case is part of the viewfinding system. It has an aperture which is shielded in the axial direction by the movable mirror. After removing this mirror, pictures can be taken from a picture tube, etc., with the test object placed directly on the stop of the side aperture. This aperture may also be used for projecting an auxiliary time base for pictures taken in the normal way.

The rotors were designed to avoid critical resonant frequencies, so that pictures can be taken within the whole range of 6000 to 42,000 frames/sec without running the risk of excessive vibrations.

Conclusion

Before the camera was delivered to the customer, a number of successful tests had been carried out. (Some specimen pictures are shown in Figs. 11 and 12.) The operational tests performed at the Meopta Works, Přerov, Czechoslovakia, were used for checking the shutter exposure times of some photographic cameras (Fig. 13). Valuable information on their operation was obtained on this occasion.

Ed. Note: The Fifth International Congress on High-Speed Photography was sponsored by the SMPTE and supported in part by the Departments of Army, Navy and Air Force through a grant administered by the Chief Signal Officer of the Army. Congress papers and related discussion will be published in the *Proceedings* of the Congress.

news and reports

90th SMPTE Convention: Lake Placid Club, Essex County, N.Y., October 1–6

Attention Authors: The work of organization and arrangement, now going forward by the Program Chairman, Topic Chairmen and Papers Committee, is around the theme of *Integration of Motion-Picture and Electronic Systems* (See the May 1961 *Journal*, p. 382.)

The deadline for Author Forms and the 50- to 75-word abstracts is July 17. Authors who have a tendency to procrastinate should bear in mind that the Program Chairman may, on July 17, be inundated by a flood of abstracts, making the task of evaluation and arrangement a difficult one. If your paper comes at the last minute or or late, its chances for good scheduling are not so good.

When referring to the List of Topic Chairmen (May Journal, p. 382) if you are uncertain where your paper fits, submit it direct to 90th SMPTE Program Chairman *C. Loren Graham*, Kodak Park Bldg. 65, Rochester 15, N.Y.

6th International Congress on High-Speed Photography Hotel Kurhaus, Scheveningen, Netherlands, September 17–22, 1962

6th Congress Chairman: *Dr. J. G. A. de Graaf*, 14, Burgemeester de Monchyplein, The Hague, Netherlands

Scheveningen, chosen as the meeting place for the 6th International Congress on High-Speed Photography, is the seaside resort for The Hague. Announcement of the final decision as to time and place of meeting was made by 6th Congress Chairman Dr. de Graaf. A brochure containing advance information and details of the 6th Congress is being prepared in the Netherlands and is expected to be ready for mailing in September 1961. *Max Beard*, 10703 E. Nolcrest Drive, Silver Spring, Md., has been appointed 6th Congress Deputy Chairman. (Mr. Beard was Chairman of the 5th Congress.) Activities of the SMPTE Instrumentation and High-Speed Photography Committee related to 6th Congress planning are expected to include assistance with the Papers Program to the extent of solicitation and review of papers from the United States. Chairman of the Committee is Morton Sultanoff, 626 Roberts Court, Aberdeen, Md. Questions relating to 6th Congress plans and activities may be addressed to Dr. de Graaf or to Deputy Chairman Beard.

Education, Industry News

Four awards in the Scientific and Technical Class II and Class III categories, voted by the Academy of Motion Picture Arts and Sciences for outstanding achievements, were presented at the ceremonies held April 17 in Santa Monica, Calif. Only one award was made this year in the Class II category, in constrast to the five presented last year (*Journal*, p. 364, May 1960). The sole recipient of the Class II plaque was Ampex Corp. which was cited "for the production of a well-engineered multipurpose sound system combining high standards of quality with convenience of control, dependable operation, and simplified emergency provisions." The system is designed to reproduce optical and stereophonic magnetic soundtracks from either 35mm or 70mm film. The complex circuits for the system are controlled by a single set of pushbutton selectors.

The three Class III Awards (two were presented last year) were presented to:

(1) Arthur Holcomb, Petro Vlahos, and the Columbia Studios Camera Department for a flicker-indicating device. Flicker has always been a serious camera problem. In most cases a flicker situation is not known until the material is processed and screened which can be annoying and costly if retakes are necessary. The flicker-indicating device provides the cameraman with a visual means of detecting the camera malfunctions which cause screen flicker.

(2) Anthony Paglia and the 20th Century-Fox Mechanical Effects Department for a miniature flak gun, designed and constructed to fire timed ammunition which realistically and economically simulates flak for special effects photography.

(3) Carl Hauge, Robert Grubel and Edward Reichard of Consolidated Film Industries for the development of an automatic developer replenisher system, which employs an infrared scanning unit with monitoring controls for precise chemical control.

A projectile ¼-in. in diameter, traveling at a speed of 26,200 ft/sec through a tank where the air pressure was equivalent to that at an altitude of 120,000 ft, was photographed at the von Karman Gas Dynamics Facility, located on the Arnold Air Force Station, Tennessee. Optical information about the nature of airflow about the projectile, and its position and attitude has been obtained by shadowgraph arrangements as well as other photographic methods. The shadowgraph can be obtained because of the tremendous rate of speed at which the projectile is traveling which creates a glow around the projectile. This "glow" automatically triggers a camera at the exact moment the projectile passes between the film and the light source, resulting in a silhouette of the projectile. In one arrangement two 4 by 5-in. externally mounted cameras were used in combination with two 15-in. Fresnel

lenses, with the plane of focus for the camera-lens/Fresnel-lens combination falling at the centerline of the range. A plane mirror provided the light path from the single spark source of illumination through the other Fresnel lens. Other data-gathering methods are being studied in a long-range missile research program.

A significant trend toward automation was illustrated by equipment displayed by RCA at the Convention of the National Association of Broadcasters held in Washington, D. C., May 7–10. Equipments designed on the building-block principle, permitting the gradual addition of modules for partial, and eventually complete, automation of TV station operations were exhibited. The display included equipment for handling the station break "panic period" and a full technical operations system. A film slide projector, cued and operated by a recorded tone signal from the RCA RT-7A tape recorder was demonstrated.

An electronic teaching machine designed and presently in use by the New York Institute of Technology, 135 W. 70 St., New York, has attracted considerable attention as one of the most highly developed of the teaching machines installed in various schools and training centers throughout the country. Still the subject of spirited debate and frequent viewings with alarm, the trend in educational procedures, ushered in by teaching-with-television, seems to be rapidly advancing toward a greater reliance upon teaching machines. especially for instruction in science, mathematics and language. The whole subject of teaching machines is an intriguing one and has been viewed with a glint in the eye of many a science-fiction writer. A widely circulated non-fiction publication called the Wall Street Journal described teaching machines as "robot teachers" (p. 1, Aug. 8, 1960). The article, by-lined by Gene Bylinsky, named the NYIT's teaching machine Mr. Atd 1 (for Automatic Teaching Device) and described him (it?) as a "chatty robot" which (who?) tests a student's understanding "by asking questions which the student answers by pressing buttons."

The description of the machine given by Alexander Schure, NYIT President, makes no reference to "robots." The NYIT system seems to differ from some of its predecessors and contemporaries mainly by the arrangement and use of its various components. It includes a punched tape unit to record students' answers, and makes use of closed-circuit television, a tape recorder or record player, earphones for audio instruction, and a microphone-like device that permits a student at his desk to talk with the (human) instructor without disturbing other students.

Erratum

January 1961
"Nontheatrical Films — Interim Report No. 2" by John Flory and Thomas W. Hope, pp. 68–72.
On p. 68, par. 1, Fig. 1 and Tables I, IV and V
For: $389 million (total dollar volume)
Read: $388 million

Electronic and other teaching aids exhibited and demonstrated at the Annual Convention of the Department of Audio-Visual Instruction (DAVI) held in Miami Beach in April supplemented a four-day program of addresses, discussions, workshop sessions and small group meetings. A report from Anna L. Hyer, Executive Secretary, DAVI, noted that the exhibit was one of the largest ever assembled for a meeting of this kind. Several sessions were devoted to the subject of the use of electronics in new methods of teaching foreign languages. Fourteen countries other than the United States were represented by audio-visual specialists who discussed audio-visual programs in their respective countries. A special group session was held to discuss the topic "Training for Film Production." Chairman of the Session was Jack Tyo, System Development Corp., Santa Monica, Calif. Discussion leaders were Melvin Brodshaug, Dean of the School of Public Relations, Boston University; and Bob Wagner, Director of the Photography Department, Ohio State University. The keynote address was given by James Finn, President of DAVI, who spoke on "The Tradition in the Iron Mask."

The Thirteenth Annual National Institute for Audio-Visual Selling will be held July 16–20 at Indiana University, Bloomington, Ind. The Institute is a joint undertaking of the National Audio-Visual Association and Indiana University. Visiting lecturers and instructors include business leaders of the audio-visual industry and faculty members of the University's Audio-Visual Center and School of Business and Economics.

The Electronics Division of the American Society for Quality Control (ASQC) is sponsoring a Conference on the subject of Maintainability to be held in October in Baltimore, Md. Inquiries should be addressed to The Martin Co., Mail No. 2000, Baltimore 3, Md. Program topics will include: Specifying Maintainability; Effects of Human Factors on Maintainability; Systems Level Trade Offs — Reliability vs. Maintainability vs. Availability; Choosing Degrees of Automaticity in Maintainability; Designing for Maintainability; Measurement and Demonstration of Maintainability; Predicting Maintenance Time; "Throw Away" Maintenance; Pricing and Costing for Maintenance; and Organization for Effective Maintenance.

A three-day International Television Symposium sponsored by The International Telecommunications Union was held May 17–21 in Montreux, Switzerland, as part of the First International Festival of TV Arts and Sciences held May 15–27. Topics covered during the Symposium included World Television Trends; Television Equipment; Color Television; and Uses of Television and Space Broadcasting.

A two-year contract for a series of medical programs to be shown over closed-circuit TV has been entered into by Theatre Network Television, Inc. (TNT) and CIBA Pharmaceutical Products, Inc. Under the terms of the contract, the programs will be produced by TNT to be shown over the Eidophor color TV projector. The first of the series was a one-hour program presented before the annual meeting of the American Academy of General Practice on April 19 in Miami. The contract calls for 10 such programs for medical groups throughout the country.

Camera Equipment Co. has been acquired by a group of New York investors headed by Robert B. Bregman of Brandenburg & Co. and Chairman of the Board of Venture Capital Corp. of America, according to an announcement made jointly by Mr. Bregman and Frank C. Zucker, President of Camera Equipment Co. Present policies and services will be continued. Mr. Zucker and other officers and employees on the management level will become officers and employees of the acquiring corporation. Plans for expansion in the equipment and electronics fields are being made.

Visual Electronics Corp., 356 W. 40 St., New York 18, has been appointed distributor for TV camera tubes manufactured by English Electric Valve Co., Ltd., Chelmsford, Essex, England. The firm manufactures both 3-in. and 4½-in. image orthicons.

Purchase of the former studios and sound stages of KCOP-TV, 1000 Cahuenga Blvd., Hollywood, from NAFI Corp., to be converted to a rental facility for independent and industrial motion-picture producers, has been announced. The property, which includes buildings covering about 19,000 sq ft located on about 32,000 sq ft of land, was purchased by Birns & Sawyer Cine Equipment Co., 6424 Santa Monica, Blvd., Hollywood 38, acting with a group of motion-picture executives. Purchase price was reported at $250,000 and an estimated $50,000 will be spent in modernizing the property. A 250-ft tower, a well-known landmark, looks down on the studio which will be known as Cahuenga Tower, Inc.

Ballantyne Co., 1712 Jackson St., Omaha, Nebr., manufacturers of theater and drive-in theater sound and projection equipment, has become a wholly-owned subsidiary of ABC Vending Co. of New York. The firm's name has been changed to Ballantyne Instruments and Electronics, Inc., but its policies and the type of products it manufactures will continue as before, the announcement stated.

A new Western Development and Service Division located at 2121 C Placentia Ave., Costa Mesa, Calif., has been established by Flight Research, Inc., P.O. Box 1-F, Richmond 1, Va. Lloyd M. Adams has been appointed Technical Director of the new division. He has served as optical and photographic engineering consultant to a number of firms and has a

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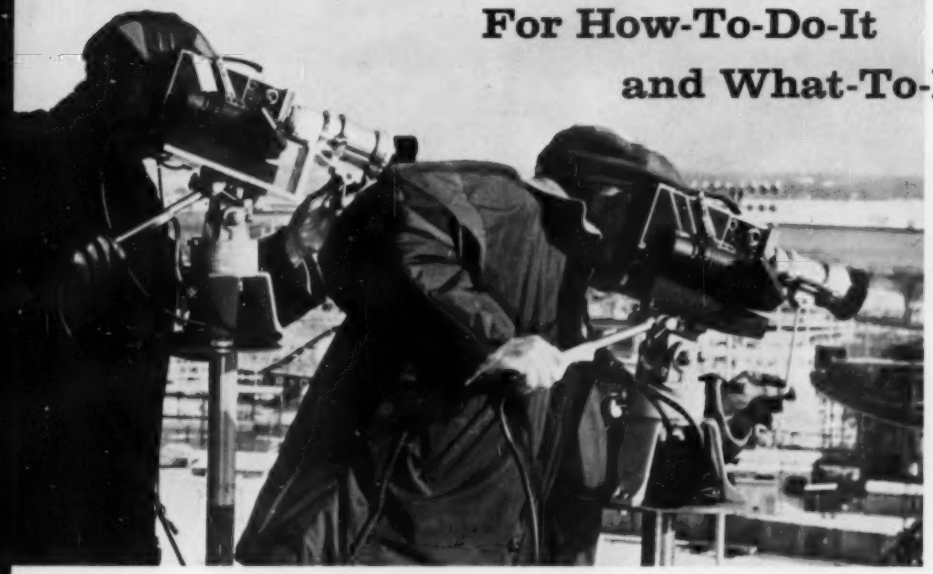

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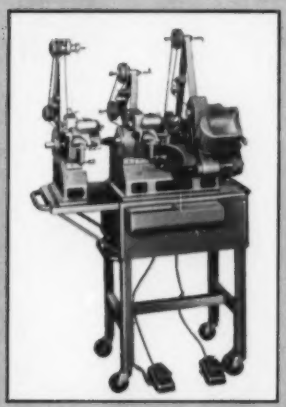

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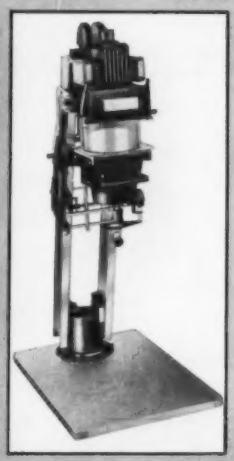

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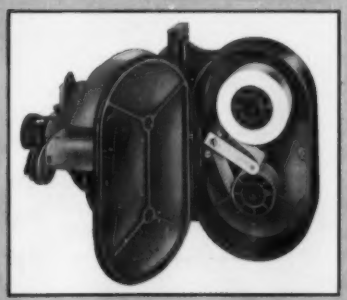

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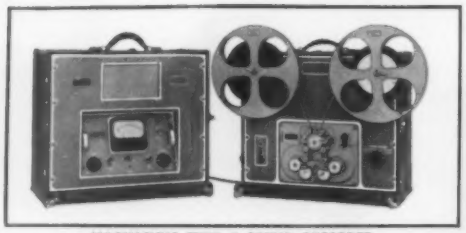

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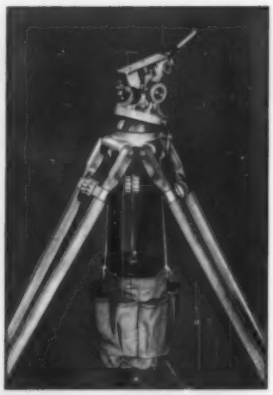

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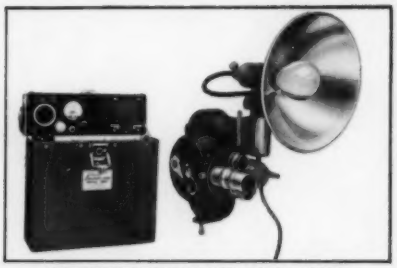

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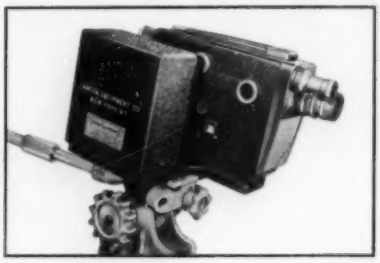

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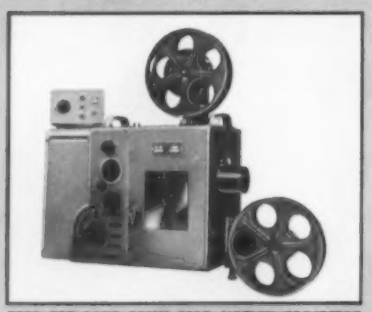

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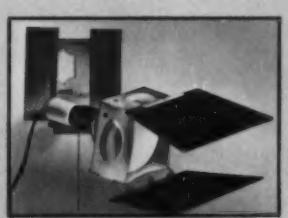

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broad experience in the design of photographic equipment and scientific instruments. Flight Research, Inc., has been actively engaged in the development and manufacture of photographic instrumentation equipment and electronic control equipment for aircraft since 1948. In January 1960, the company became a subsidiary of Giannini Scientific Corp., under an arrangement by which it continues to maintain autonomy of operation.

S.O.S. Photo-Cine-Optics, Inc., is the new name of the firm formerly known as S.O.S. Cinema Supply Corp. The new name represents the firm's expanding interests into the fields of photoinstrumentation, medical photography, x-ray and cinecardiology. Officers of the newly named firm are: President, J. A. Tanney; Vice-President, W. H. Allen; Secretary, M. E. Tanny; and Treasurer, D. J. Capano.

Measurement Systems, Inc., 53 Water St., South Norwalk, Conn., is a new firm created to develop and manufacture electrooptical and infrared equipment. President and Chief Engineer is John R. Yoder, and Vice-President and General Manager is Morton H. Mehr. Mr. Yoder was formerly Chief of the Advanced Development Section of Perkin-Elmer Corp., and Mr. Mehr was formerly a Group Leader in the same section where he was project engineer on an infrared surveillance system and directed a portion of the development and field installation of a number of large telescopic camera systems. Early plans for the new firm include work on equipment developed under research and development contracts. A prospective area of activity is in the field of electrooptics in which geometric optics, electronic circuitry and solid state devices are all parts of a complete system.

An outside broadcast television vehicle equipped by Marconi's Wireless Telegraph Co., Chelmsford, Essex, England, traveled 1750 miles overland from Chelmsford to Moscow to take part in the Moscow Trade Fair held May 19–June 4. The vehicle, equipped with four Marconi Mark IV cameras, contained all equipment needed for program production. Special emphasis was given to providing a high standard of comfort and convenience for the operators in the design of the vehicle and arrangement of equipment.

One-day rental of portable standard units of Beckman & Whitley equipment for high-speed photoinstrumentation is now possible under a new program announced by Beckman & Whitley, Inc., 973 San Carlos Ave., San Carlos, Calif. The new rental program is planned for use on small research and development projects and complements the normal equipment-leasing contracts which ordinarily cannot be arranged for less than 36 months. The new program applies to Models 189 Dynafax and Magnifax cameras and involves a daily or monthly rental charge based on the cost of the instruments and the period of rental. The rental program also includes instruction and consultation services.

Frank Lewin's song cycle *Innocence and Experience* (noted in the *Journal*, p. 300, Apr. 1961), a musical arrangement of nine poems by William Blake had its first New York performance May 8 in Carnegie Recital Hall. The obvious difficulties of creating a musical accompaniment for the poems (especially the one beginning "I saw a chapel . . ." with its strange and (to some readers) repellent Freudian imagery) were magnificently solved. The same idea, developed by a less sensitive composer could well have resulted in pleasant music entirely unrelated to Blake — more suitable for Wordsworth. Fortunately, Mr. Lewin's music enhanced rather than detracted from the poet's quality and imagery. The voice of Helen Boatright, accompanied by an ensemble conducted by Loren Glickman was entirely adequate to the demands made upon it. Mr. Lewin, who is widely known as a composer of film and theater music, is the author of the SMPTE publication *The Soundtrack in Nontheatrical Motion Pictures* which was first published in installments in the March, June and July 1959 *Journals*.

Aubrey Harris has been appointed Senior Engineer for Ampex Electronics, Ltd., Reading, Berkshire, England. He has been associated with the parent organization, Ampex Corp., Redwood City, Calif., since 1958. Previous affiliations included British Post Office Research Station; Marconi's Wireless Telegraph Co., and Station ZBM-TV in Bermuda where he was Chief Engineer.

Abstracts

Abstracts from other Journals, chosen for importance and timeliness, are published in the *Journal* from time to time. The greater number of these abstracts are translations, chiefly from the U.S.S.R., and made available by the *Kodak Monthly Abstract Bulletin*.

The subject areas are grouped below

AERIAL PHOTOGRAPHY

Technical Improvements at the LTTs (Leningrad Television Center) (in Russian), *Tekh. Kino i Televideniya, 4:* 76, June 1960.

Brief descriptions are given of a telecine machine which is capable of transmitting 8mm films, a magnetic sound-reproduction unit for use with a 16mm telecine machine and other pieces of apparatus recently produced in the Leningrad Television Center.—S.C.G.

CAMERAS AND EQUIPMENT (Except High-Speed)

The Spectrovisor, M. M. Gurevich and K. I. Kolyadin, *Optics and Spectroscopy* (transl. ed. of *Optika i Spektroskopiya*), *9:* 131–133, No. 2, Aug. 1960.

The author describes a fast spectrophotometer for the visible part of the spectrum, which traces the transmission coefficient-vs.-wavelength curves of the sample and a standard on the screen of a cathode-ray tube. Each of the curves is traced in 0.01 sec. A motion-picture camera takes 12 photographs of the screen per second, thus making it possible to record the optical aspect of the kinetics of some chemical reactions. (Authors' Abstract.)

COLOR PHOTOGRAPHY AND COLOR DEVELOPMENT

Color Reproduction with Fuji Color Negative Film. 1. The Effect of the Ultraviolet-Sensitivity of the Reproduction (in Japanese, with abstract and figure legends in English), S. Fujisawa, S. Yamaguchi and S. Watanabe, *J. Soc. Sci. Phot. Japan, 22:* 198–201, No. 4, Dec. 1959.

Since a color film is very sensitive to ultraviolet radiation, and the human eye is not, and since daylight or any artificial light contains ultraviolet radiation, the use of a filter which absorbs radiation shorter than 410 mμ is suitable for any color film. The filter gives especially good results when used in photographing greenish or yellowish objects. (Authors' Abstract.)

Use of Different Fixing Solutions in the NIKFI Processes (in Russian), N. I. Kirillov, A. M. Voitsekhovskaya and N. E. Kirillova, *Uspekhi Nauch. Fotografii, 7:* 236–239, 1960.

A number of weakly acid fixing baths have been studied for their suitability in the NIKFI processes for the processing of multilayer color film. A wide choice of fixing solutions is available. The acid content, depending upon the content of sulfite and the acidifying substance used, may vary within wide limits, provided the pH is kept constant.—S.C.G.

A Study of the Stability of the Working Bleaching Solutions Used in the NIKFI Process (in Russian), N. I. Kirillov, A. M. Voitsekhovskaya and N. E. Kirillova, *Uspekhi Nauch. Fotografii, 7:* 230–235, 1960.

A bleach bath containing potassium ferricyanide and sodium thiosulfate is used in the NIKFI process for processing multilayer color films (*Uspekhi Nauch. Fotografii, 4:* 269, 1955). Experiments have been carried out on the chemical reactions occurring during storage of the bleaching solution, and it has been shown possible to increase the stability by adding ammonia or potassium carbonate. Buffered bleaching solutions and the use of countercurrent bleaching of color films are also recommended.—S.C.G.

A Study of Incubation Aging of the Color Image on Multilayer Film Processed by Different Methods (in Russian), N. I. Kirillov, A. M. Voitsekhovskaya and N. E. Kirillova, *Uspekhi Nauch. Fotografii, 7:* 240–245, 1960.

An experimental study has shown that the character of incubation aging of a color positive image obtained on processing a color positive film by the original Agfa process (with a phosphate stop bath), by the process with two fixing baths and by the NIKFI process is practically the same. The different changes in optical density and gamma of the different layers of the film which take place during aging put the image out of color balance and produce a marked fall in its quality, which can be perceived visually. Hardening significantly decreases thermostatic aging. Unlike hardening in potassium alum solutions, hardening in formalin, in comparison with control samples, brings about an increase in the formation of new dye substances (reddish-yellow fog) in the film—S.C.G. (Translation of Authors' Abstract.)

The Problem of the Completion of Development of Multilayer Color Negative Film (in Russian), Ts. S. Arnol'd, *Uspekhi Nauch. Fotografii, 7:* 246–252, 1960.

In attempts to speed up the NIKFI method of negative color processing for multilayer films, the results were not reproducible, owing to the different degrees of "afterdevelopment" (continuation of development during washing) produced by inconstancy in the conditions of washing the film. The kinetics of afterdevelopment have now been studied in a number of solutions of salts of mineral acids and mixtures of them. Afterdevelopment was found to proceed satisfactorily in these salts over a wide range of pH value (e.g., 9.0–3.0). The author recommends that the water wash should be replaced by an afterdevelopment bath consisting of a 0.2% metabisulfate solution at a pH of 4.5. This is to be used after the diethylparaphenylenediamine developer in the NIKFI-3 process or in the ethylhydroxyethylparaphenylenediamine developer in the NIKFI-4 process. This modified processing gives a somewhat lower film speed (about 20–30%), but the color fog is approximately halved, compared with that of normal processing.—S.C.G.

FILM AND ITS PROPERTIES

Means of Raising the Stability of Hypersensitized Infrared Films (in Russian), S. M. Solov'ev and N. M. Parfenova, *Uspekhi Nauch. Fotografii, 7:* 210–218, 1960.

5-Methyl-7-hydroxy-2,3,4-tri-azaindolizine will effectively stabilize infrared films hypersensitized by means of the bath described by S. M. Solov'ev (*Uspekhi Nauch. Fotografii, 7:* 200, 1960). Treatment remains effective 20–22 days, after which fog begins to form and there is some lowering of the effective speed. The film after hypersensitization, as in Solov'ev's paper, is rinsed in water 1 min and then treated 4 min in a bath consisting of 5–8 ml (depending on the degree of fogging of the film) of stabilizer (1% aqueous solution) and water to make 1 liter. The film is then rinsed in 70% alcohol and quickly dried.—S.C.G.

FILM PROCESSING APPARATUS AND CHEMICALS

Study of Local Effects in Development and Their Influence on the Quality of the Motion-Picture Image (in Russian), Yu. I. Bukin, *Uspekhi Nauch. Fotografii, 7:* 219–229, 1960.

Local development effects have been studied in repeated intermediate printings (as many as ten times), the printings being carried out so as to keep two reference densities (a black and a white) constant. The increase in grain was shown to be due to an increase in the contrast between the grains and the background due to local development effects. A distortion of the gradation was produced, the intermediate densities tending to approximate the reference densities, so producing a stepped curve with the disappearance of intermediate tones. Fine-grain films show the effects less, a larger number of repetitions being required to give the same degree of distortion, although dry-collodion layers gave very poor results.

The effects were worsened when development was carried out without agitation, but greater agitation than the normal showed no improvement. The composition of the developer solutions was without effect, except in the case of a tanning developer based on pyrogallol, in which the local effects were enhanced.

Bromide streaks were studied by means of "effectograms," in which square patches of density were superimposed on a continuous density wedge. The effectograms were developed in a vertical position so as to allow formation of bromide streaks under the patches. The difference, ΔD, between the density of the background with and without the bromide streak was plotted against gamma. The greatest ΔD found was produced by hydroquinone with caustic alkali, giving very large fog. The quantity of potassium bromide in the developer had little influence on the effect in Amidol and in hydroquinone with sodium carbonate, but had a strong influence in hydroquinone with caustic alkali, which gives a very large fog without potassium bromide and less when the bromide is present. The effect is ascribed to the slowing down of development by the bromide and not to solution of the silver halide.—S.C.G.

HIGH-SPEED PHOTOGRAPHY AND INSTRUMENTATION

The Second All-Union Conference on High-Speed Photography and Cinematography (in Russian), E. M. Goldovskiĭ, *Zhur. Nauch. i Priklad. Fotografii i Kinematografii, 5:* 396, No. 5, Sept.–Oct. 1960.

The Conference, organized by the Commission for Scientific Photography and Cinematography of the Academy of Sciences of the Soviet Union, the Moscow State University, and NIKFI, was held in Moscow May 22–26, 1960. Seven hundred delegates took part and about sixty papers were read. Brief notes on some of the outstanding contributions are presented.—S.C.G.

High-Speed Stereoscopic Cinematography and Projection (in Russian), V. V. Garnov and A. S. Dubovik, *Zhur. Nauch. i Priklad. Fotografii i Kinematografii, 5:* 356–360, No. 5, Sept.–Oct. 1960.

A brief description is given of the stereoscopic attachment which has been devised in the Institute of Chemical Physics of the Academy of Sciences of the Soviet Union for use with the SFR high-speed camera. The picture so obtained can be used for stereoscopic projection. A frame frequency of 1,250,000/sec is claimed.—S.C.G.

Experience in Photographic Nebulae Using an Electronic Telescope, P. V. Shcheglov, *Astron. J. Soviet Union* (transl. ed. of *Astron. Zhur.*), *4:* 556–558, No. 3, Nov.–Dec. 1960.

Plates of nebulae obtained in Hα light through narrow-bandwidth, multilayered interference filters, with the aid of an electronic telescope using a photocontact tube, are described. Two response curves and one plate are reproduced. (Author's Abstract.)

Stellar Photography Using an Electronic Telescope, V. F. Esipov, *Astron. J. Soviet Union* (transl. ed of *Astron. Zhur.*), *4:* 558–561, No. 3, Nov.–Dec. 1960.

Plates were obtained by means of an electronic telescope employing a photocontact image-intensifier tube. The gain was 30 to 40 times. (Author's Abstract.)

Application of Mirror-Lens Objectives in Photographing Artificial Earth Satellites, N. V. Yakolev, *Astron. J. Soviet Union* (transl. ed. of *Astron. Zhur.*), *4:* 523–527, No. 3, Nov.–Dec. 1960.

Brief dimensional data and the main optical characteristics of a high-speed mirror-lens objective are given. The objective makes possible the photographing of artificial earth satellites of the sixth magnitude on film with a sensitivity of about 500 $lux^{-1}\ sec^{-1}$. (Author's Abstract.)

The Work of the Camera Section at the Second All-Union Conference on High-Speed Photography and Cinematography (in Russian), A. S. Dubovik and A. B. Granigg, *Zhur. Nauch. i Priklad. Fotografii i Kinematografii, 5:* 396–400, No. 5, Sept.–Oct. 1960.

The papers presented to the Camera Section are reviewed.—S.C.G.

An Equipment for Automatically Processing Time Multiplexed Telemetry Data, N. Purnell and T. T. Walters, *Jour. Brit. IRE, 21:* 257–274, Mar. 1961.

An equipment is described for processing magnetic tape recordings of frequency-modulated time-multiplexed telemetry data. Details are given of the way in which the input signals are derived and the method by which the recordings are made. The equipment produces two forms of output: analog graphs on paper film and digital records on punched cards. The performance achieved and the methods of checking this performance are detailed.

SENSITOMETRY AND IMAGE STRUCTURE

Studies on Graininess and Granularity. I. A New Granularity-Measuring Instrument (in Japanese), S. Ooue, *J. Soc. Sci. Phot. Japan, 23:* 7–10, No. 1, Mar. 1960.

A new instrument for measuring granularity of photographic materials is described. It consists of four parts: a high-speed-scanning microphotometer which scans a photographic film at the rate of 100 mm/sec; a d-c amplifier; a frequency analyzer with 20 narrow bandpass filters, which analyzes the waveform to its power spectrum; and a meter which indicates the root-mean-square value of the current. The scanning aperture, on which the magnified image of grain structure is projected by a microscope optical system, can be replaced by a revolving disc. Measurement of the power spectrum of grain structure and also measurements of the granularity-density function can be made with this instrument. Numerical values of granularity, determined with the diameter of the scanning aperture selected so that its spatial frequency character corresponds to the response function of the eye, correlate well with graininess evaluations. The correlation coefficient, for granularity measured with a scanning aperture of 10μ and graininess evaluated from 14X enlargements, was 0.90.—T.H.J.

A Photographic Method for Measuring Light Fluxes (in Russian), V. N. Adrianov and G. L. Polyak, *Problemy energetiki*, Acad. Sci. U.S.S.R., Moscow, 1959, pp. 470–482; *Referat. Zhur., Fiz.*, Abstract No. 25052, Sept. 1960.

Some problems in photographic photometry are studied in connection with the measurement of a light field in light models of a radiating hot body. Theoretical consideration is given to the relative error in the determination of the absolute illuminance by photographic photometry as a result of nonuniformity of the emulsion layer, its development and the measurement. Curves are constructed showing the relation between the relative error and the density and contrast of the photographic layer; the error is a minimum at a density of ~ 0.4 and diminishes with increase in gamma, reaching $\sim 2\%$ in the best cases. Characteristic curves have been determined for the [Soviet-made] MZ film with different angles of incidence of the light flux (from 0 to 83° 15′) under a constant exposure. As the angle is increased, a decrease is seen in the speed of the film as a result of a parallel displacement of the characteristic curve, which is small up to angles of 40–45° and then increases. This fall in sensitivity is brought about, in the first place, by the increase in the coefficient of reflection of the surface of the photographic layer as the angle of incidence is increased, and in the second place, by a change in the light-scattering characteristics of the emulsion. A selenium cell under analogous conditions exhibits a change in properties only at angles >60°. A parallel study of a single field both by

photographic photometry and by the photoelectric method showed good agreement in the values of illuminance obtained. The photographic method is considered quite adequate for the task in hand.—S.C.G. (Translated from *Referat. Zhur., Fiz.*)

TELEVISION

Training for Operating and Maintaining Television Studio Broadcasting Equipment

The B.B.C.'s pioneering work in the training of staff for operating and maintaining television studio equipment is described. A general discussion on training policy and recruitment is followed by an outline of the training schedule and training techniques. A detailed survey is given of the methods used for training technical assistants and technical operators in the B.B.C. Television Service. The standard which must be reached by the new recruit if he is to continue in the Corporation's service is indicated, and courses provided for technical assistants and operators worthy of promotion are described.—K. R. Sturley and A. E. Robertson, *Jour. Brit. IRE, 20:* 821–839, Nov. 1960.

Henri de France Colour Television System

The paper describes the work done by the Cie Française de Télévision (C.F.T.) on the Henri de France system of colour television. First it defines the objectives of the team of research workers who have carried out this development. It then stresses the fundamental aspects and the special features of the system and describes the encoding and decoding units. Finally, it gives the practical results and theoretical aspects on the ease of transmission of the coded signals.—R. Chaste and P. Cassagne, *Proc. Inst. Electrical Engineers, 107:* 499–511 Nov. 1960.

Propagation Measurements at 3480 and 9640 Mc/s Beyond the Radio Horizon

The paper gives an account of scatter-propagation measurements made at S- and X-band during the period May, 1957 to May, 1959. The work at S-band continued throughout the whole of this time, while the X-band measurements were made during the period of a year from June, 1958 to May, 1959. The S-band transmitter, using a 3.480 Gc/s c.w. magnetron with a power output of 500 watts, was established at Start Point in Devon. Receiving terminals were set up at Wembley, Middlesex, and Witnesham, Suffolk, at distances of 173 and 247 statute miles, respectively, from the transmitter, the former being maintained in operation throughout the whole of the experimental period and the latter for a period of nine months from September, 1957 to June, 1958. Diurnal and seasonal variations in the median level of the received signal are discussed and a comparison is made of measurements taken simultaneously at Wembley and Witnesham. The distribution of the S-band fading rate as a function of level is studied and a limited amount of work concerned with the distribution of the duration of fades below a given level and the power spectrum of the detected signal is described. The transmission path for the X-band system, which used a pulsed magnetron at a frequency of 9.640 Gc/s, also lies between Start Point and Wembley; the pulse length was 2 microsec and the pulse-repetition frequency 500 c/s, the peak power in the pulses being 180 kW. The X- and S-band links were operated together whenever possible, and a comparison is made of the median level and fading rate of the signals received simultaneously at the two frequencies over the same propagation path. In addition, a series of measurements to investigate the aerial coupling loss of the X-band system are described.—G. V. Geiger, N. D. La Frenais and W. J. Lucas, *Proc. Inst. Electrical Engineers, 107:* 531–546, Nov. 1960.

The Use of a High-Gain Television Transmitting Aerial in a Populous Area

The paper is concerned with the provision of satisfactory signals to viewers in the immediate vicinity of the Crystal Palace television station, where an 8-tier aerial is sited in an urban area. The problem was complicated by differences between the halves of the aerial, but a satisfactory performance was ultimately obtained. The only serious discrepancy between theoretical and experimental results could be removed by taking account of reflection at the ground, ignoring the

effect of buildings. In order to provide continuity of service in spite of any single breakdown, the halves of the aerial were originally supplied from separate transmitters; this arrangement had to be abandoned, since it proved impossible to provide undistorted signals at receiving points where the contributions from the transmitters were in phase opposition.—G. D. Monteath, G. H. Millard and D. J. Whythe, *Proc. Inst. Electrical Engineers, 108:* 65–74, Jan. 1961.

The Perception of Reproduction Colors in Color Television (in Japanese, with abstract and figure legends in English), I. Soma, *Studies of Color, 7:* 29–39, No. 2, 1960.

The author, with the assistance of sixty observers, sought to establish the visible limits of color reproduction in color television, and subsequently, the limits of color names and memory colors. A comparison was made, under standard illumination, between colors reproduced by color television and color chips in The Guide to the Color Standard. Six familiar color names and the memory colors of eight familiar objects were determined from an array of 983 recommended Munsell color chips. The results show that (1) colors of high and low values are not well reproduced; (2) hues shift either to blue or green; (3) colors of high chroma are apt to be reproduced a little low; (4) the aberration of yellow is the greatest; and (5) blue, green and purple stay within the limit of the color names, with yellow deviating the most. Several diagrams show the variance of the colors examined. (Author's Abstract.)

A Mobile Laboratory for UHF and VHF Television Surveys, E. W. Taylor and L. C. Munn, *BBC Engineering Div. Monograph,* No. 34, Feb. 1961.

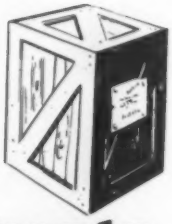
This report describes the mobile laboratory used by the BBC Research Department for assessing the reception conditions during the Band I/Band V comparison tests carried out in 1957–1958. The mobile laboratory was equipped for the measurement of vision field strength and test waveforms, and the subjective assessment of the picture quality resulting from the transmissions from Crystal Palace.

Tables of Horizontal Radiation Patterns of Dipoles Mounted on Cylinders, P. Knight and R. E. Davis, *BBC Engineering Div. Monograph,* No. 35, Feb. 1961.

This monograph contains tables of the horizontal radiation pattern (h.r.p.) of a dipole mounted on a cylindrical mast. The tables were calculated on a digital computer and this enabled a comprehensive range of mast sizes and dipole spacings to be covered. The tables should satisfy most requirements arising in the design of vhf aerial systems for transmitters. Although applicable to cylindrical masts, they may be used with little error for masts of square or triangular cross-section provided the widths of the mast faces do not exceed 0.5λ and 0.3λ respectively. The tables are intended not merely to give the pattern of a single dipole but also to simplify the calculation of the patterns of arrangements of more than one dipole spaced around a mast; this is achieved by appropriate addition of the contributions of each dipole and an analog computer has been developed in the BBC Research Department to facilitate this operation.

The Standardization of International Microwave Radio-Relay Systems, W. J. Bray, *Proc. Inst. Elec. Eng, Pt. B:* 180–200, Mar. 1961.

Microwave radio-relay systems using line-of-sight paths now form a substantial part of the international trunk network, both for multichannel telephony and for television. In order that such systems shall provide satisfactory transmission over long distances they must conform with certain minimum performance standards. Furthermore, in order to facilitate the interconnection of radio-relay systems with one another and with line systems, certain common characteristics are necessary. The establishment of links across national frontiers also requires the use of equipment with similar characteristics in each country. The paper outlines the work of the International Radio Consultative Committee (C.C.I.R.) and the International Telegraph and Telephone Consultative Committee (C.C.I.T.T.) in defining preferred characteristics for microwave radio-relay systems using line-of-sight paths, and discusses the technical and other reasons for the particular values adopted. The need for preferred characteristics for radio-relay systems using tropospheric-scatter propagation is also referred to.



new products

(and developments)

Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products or services.

A new electronic system for editing tape-recorded TV programs has been announced by Radio Corp. of America. Developed for NBC and RCA Electronic Products by RCA Astro-Electronics Division, Princeton, N. J., the system is constructed to enable the television editor to select, view, compare and evaluate groups of frames in tape-recorded programs and to make immediate selections of beginning and end frames of sequences to be removed or altered. The system was described in a paper by William J. Haneman and Harvey Ostrow presented at the SMPTE Convention held in Toronto, May 7-12.

Basic operation of the new system involves recording on the tape identifying numbers with each frame and the subsequent use of the numerical signals to control the automatic selection of specific frames of interest to the editor. The equipment comprises three major units: a frame-number generator, a frame-selection and display console, and a tape search-and-splice console. The identifying numbers can be recorded with the original tape or added later to a prerecorded tape. When the tape is played back the identifying frame number appears above each picture as it is viewed on the display console. The picture sequence can be stopped for as long as five minutes to permit further study. After the tape is transferred to the search-and-splice unit, built-in dials are used to specify the identifying frame numbers of frames to be located. The tape is then played back on the unit, and when a frame number corresponding to the dial setting is reached the tape stops automatically with the frame position and precise location for splicing indicated.

Immediately applicable to broadcasting, the system is expected to have broad application to large-scale picture library systems, such as pictures from satellites.

The VR-1002, fifth in the series of the Ampex Videotape recorders, was introduced by Ampex Video Products Co., Redwood City, Calif., at the NAB Convention held in Washington, D.C., in May. The new model is designed to include major innovations and refinements in operating

controls and circuitry. New features include the AFC Modulator/Demodulator, which incorporates automatic frequency control of the carrier and simplified arrangement of carrier frequency and deviation with built-in zero-center metering, and the new Mark III Head Assembly. The new head assembly is constructed with four pre-matched record/playback heads preset to within 0.05 μsec with respect to quadrature. It is said to minimize geometric picture distortion and improve performance characteristics. The new machine occupies

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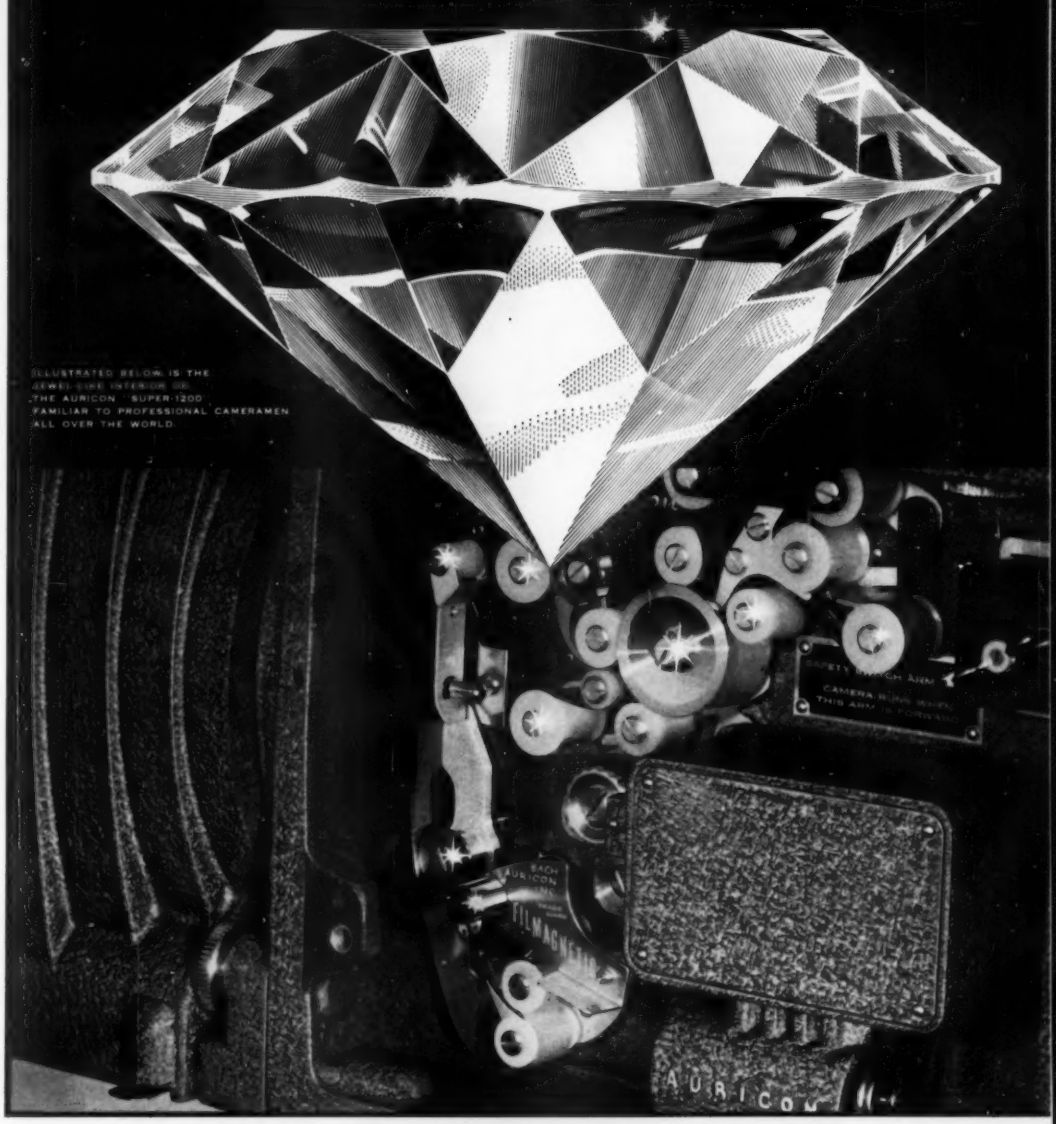

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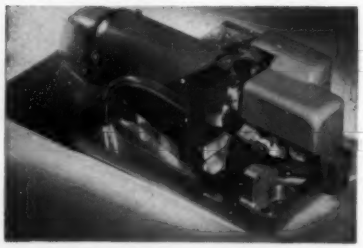
11½ sq ft of floor space and has a two-cabinet construction with an overall height of 5 ft, 5 in. It has fewer tubes and fewer transistors than earlier models to simplify maintenance and adjustment. It is priced at $41,950.

The Ampex Selective Editing unit, an electronic device used in conjunction with Ampex's Inter-Sync TV signal synchronizer for pushbutton-controlled editing, has been introduced by Ampex Video Products Co., Redwood City, Calif., as a regular accessory for the Ampex Videotape Recorder. The accessory kit consists of an all-transistorized chassis, which fits into 3½ in. of rack space, and a full-track erase assembly for replacement of the recorder's standard full-track erase head. The new unit is designed to compensate electronically for the physical separation of the erase head and the video recording head in the recorder's tape transport system. Purpose of the new unit is to make it possible, with one recorder, to assemble prerecorded segments into a complete program or commercial tape without splices or discontinuities in picture transitions. It is also used to erase any portion of a tape and to insert new material without cutting or splicing. When new material is inserted only the audio and video portion of the previous recording is erased. The original control track is retained for added stability. A three-position rotary switch allows for selection of three modes of operation: Inoperative, Insert and Assemble.

A new type of video head, designed to provide longer operating life and improved recording quality, has been introduced by Ampex Video Products Co., Redwood City, Calif. Called the 340 Ferrite Video Head it features unitized transducers with wear-resistant, all-ferrite tips, said to provide operating life more than 10 times that of the standard video head assembly, and a signal-to-noise ratio of 46 db. It is planned to supply the new head assembly as optional equipment for Ampex Videotape



Recorders. It is expected to be commercially available by August with a price of $2950.

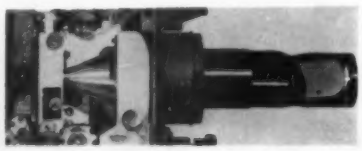
An optical multiplexer (Type PF-11-A) has been designed by Eastman Kodak Co. for General Electric. The multiplexer, announced by General Electric Communication Products Dept., P.O. Box 4197, Lynchburg, Va., uses frontsurface mirrors to project the image from film and slide projectors, including the latest improved version of the G-E continuous-motion, TV projector system. The system is designed so that the center line of the projector output is horizontal and 48 in. above the floor. Both the multiplexer and the improved projection system were introduced at the NAB Convention held in Washington, D.C., in May.

A model of equipment for future use in a fully-automated, computer-controlled television station with all its operations carried on by an integrated electronic system was displayed by Radio Corp. of America at the convention of the National Association of Broadcasters held in Washington, D.C., in May. RCA-produced automation equipments include a continuous loop for film projector, semiautomatic live cameras, random access tape with automatic cue, and an automatic announcer, the latter shown for the first time at the NAB convention. The announcer is a combination of RCA's RT-7 cartridge tape recorder and its TP-7 slide projector, providing a complete sequence of slides synchronized with a recorder announcement. The unit may be operated by pushbutton or by a signal cue from other gear. Another development toward automation is the simplification of controls by use of four basic panels to reduce the knob-button complex. Of present advantage for manually-controlled operations, this development is said to be a step toward eventual automation.

A single-cubical 1000-w VHF high-channel TV transmitter, developed by General Electric Co., may be used in the future as the base for a block-building approach to a 35,000-w VHF high-channel transmitter for telecasting at maximum commercial power. A second cubicle can be added to the 1000-w unit to form a compact 5000-w transmitter. The 5000-w transmitter can also be used as the driver for the G-E Type TF-14-A amplifier. Announcement was made by the General Electric Communication Products Dept., P.O. Box 4197, Lynchburg, Va.

The CECO High-Speed Editing Table, introduced by Camera Equipment Co., 315 W. 43 St., New York, is designed for

rapid film scanning and is available in 35mm and 16mm models. The unit, which includes a viewer, operates at a speed from zero to 250 ft/min in both forward and reverse, and is also designed to stop the film action on a single frame instantaneously without damaging the film. The viewer has a 4 by 6-in. screen and is equipped with a footage counter and optical sound head. A conveniently located panel contains speaker, amplifier and controls for both speed and sound. The unit is suggested for television and film library use where rapid inspection of prints, insert spots, commercials, etc., is required. Dimensions are 60 in. long, 30 in. deep, with a table height of 36 in. The 16mm table is priced at $2500. The 35mm table is priced at $1750. Accessories, including a time counter, are priced separately.

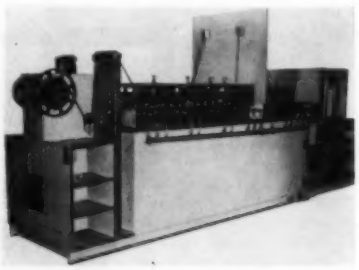


The projector alignment tool kit developed by the Motion Picture Research Council is now available from the National Theatre Supply Co., 50 Prospect Ave., Tarrytown, N.Y. The kit contains a film path gauge for mechanically lining up the fixed guide roller, the guide rails, and the narrow-tooth intermittent sprocket; an optical alignment tool for positioning the carbon arc and the mirror on the optical axis of the projection lens; and sufficient footage of 35mm all-purpose projector alignment film to make loops. This film is used in conjunction with the alignment tool to center the image on the film on the optical axis. The optical alignment tool can be used with the projector in full operation. An adjustable observation mirror is provided so that all alignment operations can be made from the projectionist's usual working position. The complete tool kit is priced at $59.50.

A description of the 16mm color film used to record the reactions of the second astronaut to reach outer space has been released by Ansco Division, General Aniline & Film Corp., Binghamton, N.Y., subsequent to government clearance, with an announcement that it will soon be commercially available. The film, Anscochrome F P C – 132, was the result of more than nine months research by Ansco preceding the development of a film for the space program that would be suited exactly to the dim light and other conditions within the Mercury capsule that carried Lt. Shepard aloft on May 5.

Expected to be useful in industrial research, such as flame study, instrumentation and other specialized applications, the film has a present minimum rating of ASA200. However, experiments have indicated that a higher rating, up to ASA-500, is acceptable because of the film's consistently good latitude, which permits wider lens openings without the necessity of forced processing. It has been suggested that with forced processing, the film's speed range may be extended even further. The film is essentially a daylight type film (6000 K), but may be used under tungsten illumination in special cases. Its speed, in common with that of other color films, is considerably reduced by the use of filters necessitated by artificial light, so for most purposes requiring artificial light the manufacturers recommend a Super Tungsten type film.

The grain of the new color film is of moderate size and gradation similar to that in Super Anscochrome, the announcement stated. Resolution is between 45 and 55 lines/mm. The film will be available in 16, 35, and 75mm, and special sizes and spool and core specifications can be supplied.



The Houston Model 515-K2, a professional, double-duty processor for Kodachrome K-2 film, has been announced by Houston Photo Products Division, Houston Fearless Corp., Burbank, Calif. The machine automatically processes both 8/16mm and 35mm film, either simultaneously or separately, or two reels of 8/16mm can be developed at the same time. Independent drive systems for the two film sizes are on opposite sides, but utilize the same tanks for solution, rinse and wash, plus a common drybox. A single all-purpose driveshaft on the bottom eliminates film tension. Speeds are 12½ ft/min for 8/16mm and 5 ft/mm for 35mm. The machine's equipment includes automatically controlled heating and refrigerating, automatic On-Off switch, loading elevators, pumps, replenisher tanks, compressor, air filters, drybox and control panel. The unit is 16 ft long and 5 ft high and does not require a platform. It is priced at $27,750.

A new film processing machine which uses chemicals in a viscous form (about the consistency of heavy lubricating oil) to process black-and-white 16mm film at a speed of 36 ft/min and a dry-to-dry time of 1 min has been announced by Eastman Kodak Co.

The machine, called the Eastman Viscomat Processor, Model 10P, is about the size of a four-drawer file cabinet (21 in. wide, 16 in. deep, 58 in. high). It weighs 330 lb. It operates on standard 110 a-c current, and requires only two hose connections — one to bring in water, heated to 130 F, at the rate of 1 gal/min, and the other to drain the wash-water.

When the film is processed it is uniformly wetted and brought to processing temperature before the chemical is applied, through the use of pressurized water sprays which saturate the processing chamber with water vapor at a uniform temperature of 125 F. The viscous material is drawn into the processor through a gear-driven meter-

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The transport is a self-driven unit *incorporating the film pulling mechanism, a miniaturized semi-conductor reproduce amplifier, drive motor and torque motors in one assembly. Basically a magnetic reproducer, it is also used as a magnetic recorder, optical reproducer, and optical recorder by means of optional attachments.*

A cabinet can be supplied to *house five complete film reproducers or various optional attachments and transports utilizing the 77" panel space. A semi-conductor power supply mounts inside this cabinet.*

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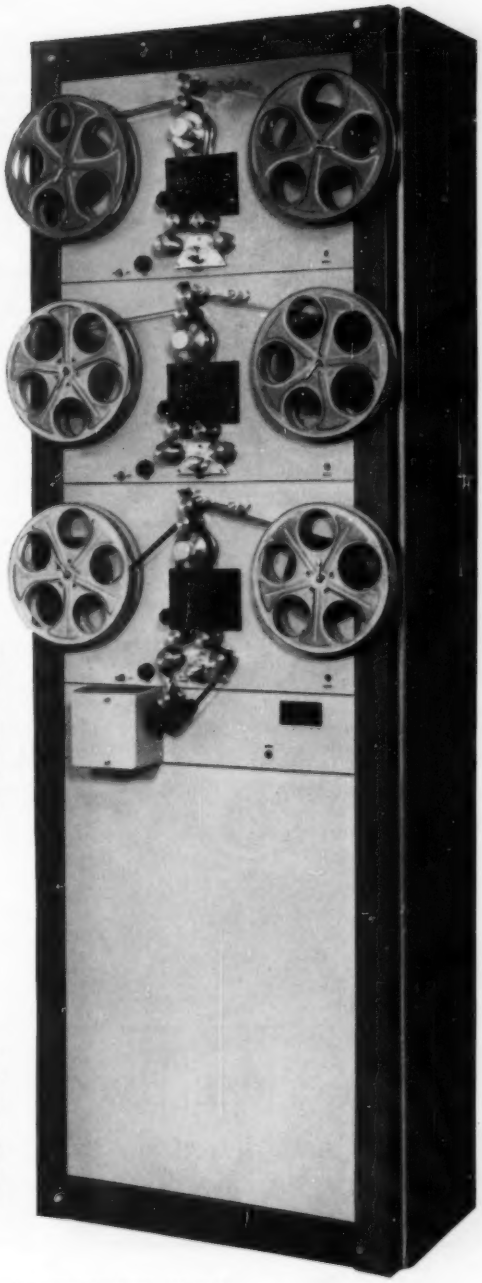

VIEW OF THREE SERIES 400, TYPE MD497 DUAL FILM WIDTH, 17½mm AND 35mm MAGNETIC REPRODUCERS, AND ONE OD435, 35mm OPTICAL REPRODUCER ATTACHMENT INSTALLED IN THE CS400 CABINET.

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TYPE	FILM WIDTHS	SPEEDS(fpm)	OPTIONAL ATTACHMENTS ACCOMMODATED		
MD416	16mm	36	MR416 MAGNETIC RECORD	OD416 OPTICAL DUBBER	OR416 OPTICAL RECORD
MD417	17½mm	90	MR417 MAGNETIC RECORD		
MD435	35mm	90	MR435 MAGNETIC RECORD	OD435 OPTICAL DUBBER	OR435 OPTICAL RECORD
MD447	17½mm	45	MR447 MAGNETIC RECORD		
MD437	COMB. 17½/35mm	DUAL 45/90	MR437 MAGNETIC RECORD	OD435 OPTICAL DUBBER	OR435 OPTICAL RECORD
MD427	17½mm	DUAL 45/90	MR427 MAGNETIC RECORD		
MD497	COMB. 17½/35mm	90	MR437 MAGNETIC RECORD	OD435 OPTICAL DUBBER	OR435 OPTICAL RECORD
MD436	COMB. 16/35mm	DUAL 36/90	MR436 MAGNETIC RECORD	OD416 AND OD435	OR416 AND OR435

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ing pump. The feed system contains a reservoir which eliminates any air from the material before it is pumped. When applied to the film, the viscous chemicals are extruded through a hopper which applies a thin, uniform layer across the entire surface of the film. The chemicals are applied in a downward direction while the film moves upward.

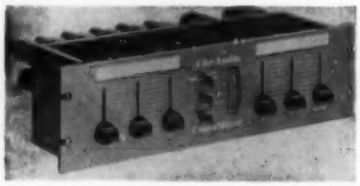
Production models of the Viscomat are expected to be available about January 1, 1962. The price will be $12,500.

A two-part paper presented at the 89th Convention in Toronto described the new method and the machine. Authors of Part I, entitled "Viscous-Layer Processing of Motion-Picture Film," are George E. Cummins, John R. Turner and Robert J. Wilson. Authors of Part II, "A Machine for the Rapid Processing of 16mm Films," are Paul A. Hermle and Harold D. Lowry.

The Perfectone EP6A Recorder and Ryder Sync Generators, Transformers, and accessories have been announced by Magnetic Sales Corp., 1147 North Vine St., Hollywood 38. These equipments (See "Improved Synchronizing System Using Magnetic Tape," by Loren L. Ryder, in earlier pages of this issue of the *Journal*) are designed for use in motion-picture and TV studio productions. The 16-lb recorder is priced at $1285. The Sync Generators are available for the Bolex H-16, Eastman Kodak Cine-Special and for Mitchell 16mm wild camera motors, each priced at $145; and for Arriflex 16mm, Arriflex 35mm, and for Auricon Cine Voice cameras, priced, each, at $170. Sync transformers, which are used in place of the generators when the camera is being driven by a synchronous motor are priced at $30 for single phase, 120-v, 60-cycle, and at $40 for three-phase, 220-v, 60-cycle. Various accessories and modifications for and of these equipments are also available.

A transistorized playback synchronizer for synchronizing ¼-in. tape in playback with sprocket-driven film has been announced by Magna-Tech Electronic Co., 630 Ninth Ave., New York 36. The device, designated Type 92B, is designed to correct speed deviations of 20% to −20% from sync speed. It can be used with most tape transports. The unit is mounted in 12¼ in. of rack space and weighs 38 lb. It is priced at $1920.

A new series of tape recorder/reproducers has been announced by Midwestern Instruments, Inc., 41st and Sheridan Rd., Tulsa, Okla. Called the Magnecord 748, the recorder has a tape speed of 3¾ in./sec or 7½ in./sec. It is capable of stereophonic, monophonic and sound-on-sound recording. It accommodates up to 10½-in. reels and can be ordered with ¼-track or ½-track heads. A direct drive hysteresis synchronous motor is incorporated to provide timing accuracy of ± 3 sec in 30 min of playing. At 7½ in./sec, the frequency reponse is said to be 40 to 15,000 cycles/sec, ± 2 db with flutter and wow held to 0.15%. Speaker/amplifiers are available as optional equipment. The 748-4 stereo-stereo recorder/reproducer, complete with case and ¼-track head is priced at $924. The 784-44 with a fourth head (¼-track) is priced at $965.

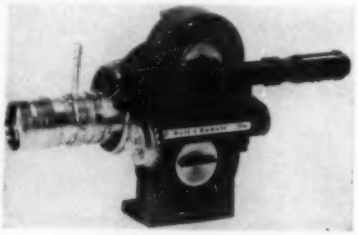


A new mixer amplifier, available in two versions — a 5-position single channel and a 4-position single channel stereophonic — has been announced by Oliver Berliner, UltrAudio Products, Dept. P-10, 7471 Melrose Ave., Los Angeles 46. Name of the new product is CustoMixer, so called because of the design which permits users to purchase only the plug-in, shock-mounted preamplifiers and input transformers required for the specific application. Both versions incorporate the Line-Aten straight-line volume control. According to the announcemenet, input and output impedances are from 500 to 600 ohms plus hi-z. Each output line has an illuminated VU meter, with further provision for stereo headphone monitoring and feed to external power amplifiers and public address systems. Each unit incorporates a self-contained, fused silicon rectifier power supply. Both versions are priced at $480.

Three new models of the Simoramic Spectrum Analyzer have been announced by Federal Scientific Corp., 615 W. 131 St., New York 27. These are Models 505, 110, and 4A. Model 505, said to cover simultaneously the frequency band from 50 cycles/sec to 5000 cycles/sec, features variable resolution from 35 cycles/sec to 350 cycles/sec, thus providing a high degree of flexibility, particularly in the analysis of speech signals. Model 110 is a delay-line synthesized Fourier analyzer operating at a theoretically maximum information extraction. It is designed to permit Fourier analysis of signals in the audio spectrum with a 1.3 cycle/sec resolution. Model 4A is a high-speed, fine-resolution analyzer operating in real time and designed to cover simultaneously the frequency range 1 cycle/sec to 200 cycle/sec without the use of contiguous filters, because of the incorporation of special frequency conversion circuits.

The Green-Bartlett Colorimeter is a machine that can "see" colors and that can automatically sort and grade products on the basis of color variations at a speed far beyond human capabilities. Developed by Allied Research Associates, Inc., 43 Leon St., Boston 15, Mass., the machine combines an electronic-optical head with a small-scale digital computer. Light reflected from a colored material to a photodetector generates a series of signals which represent the tristimulus values. These signals are fed to a computer where coded color information is converted to digital form and stored for subsequent actuation

of sorting mechanisms or process controls. In a demonstration of the first developmental model, the machine handled articles at a rate of 10 per second, sorting them into some 40 different color categories. According to the announcement, it is expected that further developments of the basic system may lead to applications for high-speed continuous scanning devices.



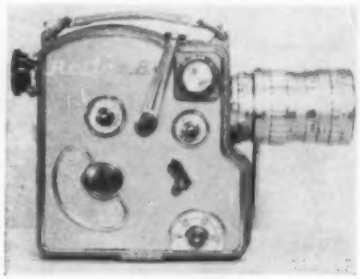
The Traid Twenty-Eighty Variable Focal Lens is now available with a built-in viewfinder which may be positioned for any spot in the 360° range around the camera. The framing mask can be rotated for horizontal positioning and the eyepiece closes to prevent feedback of light. The lens fits any "C" mount 16mm camera and provides focal lengths from 20mm to 80mm for wide angle, normal or telephoto shots. The lens with viewfinder is priced at $450. It is a product of Traid Corp., P.O. Box 648, Encino, Calif.

A Kinoptik lens with a wide-angle coverage of 197° has been announced by Karl Heitz, Inc., 480 Lexington Ave., New York 17. The lens, 1.9mm *f*/1.9 (in "C" mount) for 16mm motion-picture and TV cameras, is a custom-ground, 9-element Apochromat. It gives a round image, 8.7mm in diameter. Used for photographing interiors, panoramic views, underwater scenes, missiles, etc., it is said to be capable of photographing an area behind the photographer operating the camera. The lens has 3-color correction and is T-stopped and color-matched to other Kinoptik lenses. It is priced at $1250.

A special adapter which makes it possible for cameramen to have their prescription lenses fitted in the eyepiece assembly of the Arriflex 16 has been announced by Arriflex Corp. of America, 257 Park Ave. South, New York 10. The adapter is designed so that the prescription lens is permanently placed in a small subassembly which may be slipped on and off the finder eyepiece. A blank slip-on ring may be substituted for the prescription lens assembly to permit the camera to be used by other cameramen. The prescription lens holder is priced at $28.00 and the blank slip-on ring is priced at $8.00.

The 8mm Director Reflex motion-picture camera introduced by Bell & Howell, 7100 McCormick Rd., Chicago 45, features a through-the-lens or reflex electric eye to prevent the photocell from seeing and responding to light outside the area that will appear on film. The new camera also has through-the-lens viewfinding and focusing and is available in both roll-film and magazine-load models. The new camera also has a zoom lens with an electric

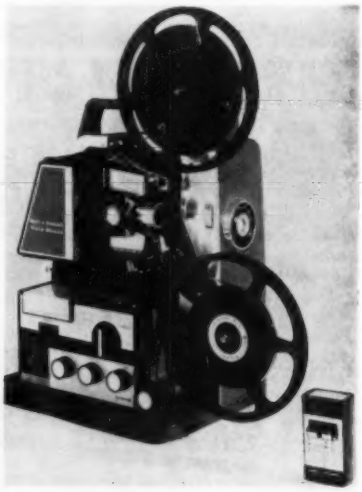
motor to assure smooth zooming action and to enable the lens to be zoomed when the camera is not in motion as an aid toward composition or focusing. The photocell in the new camera is located behind the lens so that its field of view is limited to the area covered by the lens. A sensitive cadmium sulfide photoresistive cell is used instead of the conventional selenium photocell. Power is supplied by a tiny mercury battery. The roll-film camera (Model 434) is priced at about $349.95. The magazine-load version (Model 444) is priced at about $369.95.



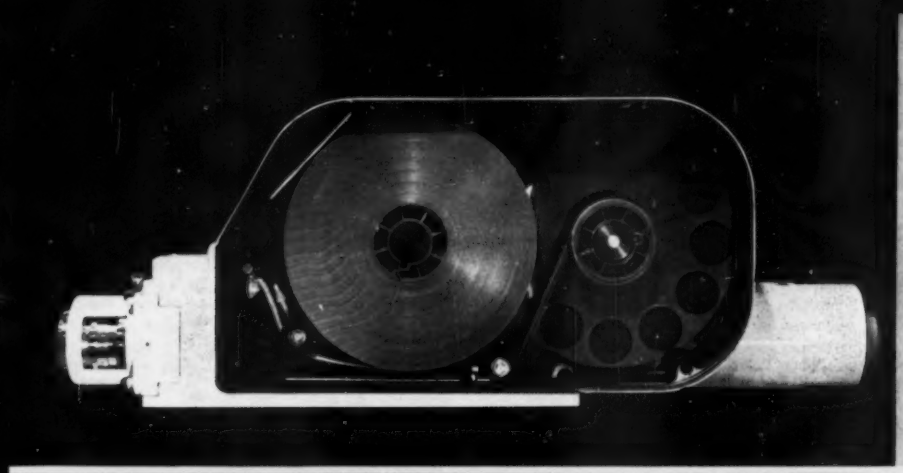
The Camex CR Dual-Reflex 8mm movie camera, announced by Karl Heitz, Inc., 480 Lexington Ave., New York 17, supplements a parallax-free through-the-lens viewing system with a behind the lens exposure meter for continuous light adjustment before and while filming. ASA ratings from 10 to 320 and film speeds from 8 to 32 frames/sec are set on a dial. The correct diaphragm opening is set by matching the needle with the center line in the reflex image. Lenses are available from 6.5mm up to 145mm; zoom lenses are available with a continuous focusing range from infinity down to 1 in. The price range is from $259 through $499, depending on the lens.

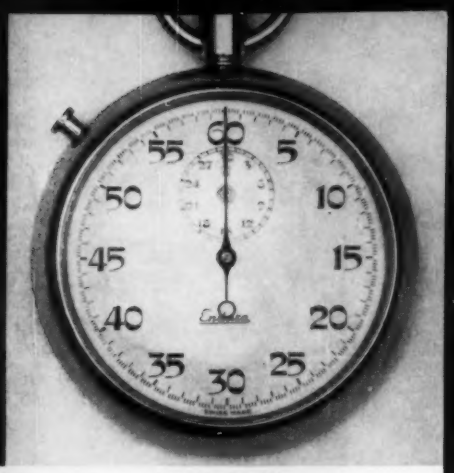
A new slidefilm projection process that uses a rotating light beam to scan an optically recorded soundtrack on a still picture filmstrip has been announced by Kalart Co., Plainville, Conn. Designated the Kalart Soundstrip Projector, the device (8½ in. high, 9 in. wide, and 15 in. long) incorporates a 35mm projector, sound scanning mechanism with audio amplifier, and controls. A loudspeaker is built into its removable cover. A Soundstrip program produced on standard 35mm motion-picture film (either color or black-and-white) contains a series of pictures arranged alternately with recorded sound messages in synchronized relationship. As each picture is projected on a screen, its related sound message is scanned and reproduced through the built-in amplifier and speaker. Each sound message can contain up to 18 sec of program time, and at the end of each message the film automatically advances to the next picture and sound frame. A "Hold-for-Discussion" switch permits the operator to interrupt the program at the end of any recorded message to add his own remarks. A Repeat Control allows the operator to repeat a picture and its related sound message as often as he wishes by pushing a button on the projector. The projector may also be remotely controlled. The price will be under $400.

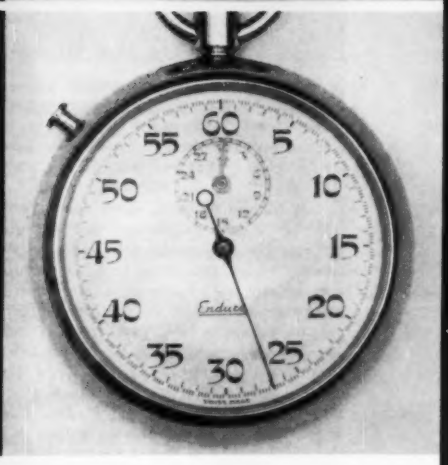
The Cinephonic 22, an 8mm rear-view sound motion-picture projector, weighing approximately 15 lb, was introduced by Fairchild Camera and Instrument Corp., 580 Midland Ave., Yonkers, N.Y., at a meeting of the National Visual Presentation Association held in May in New York. Announcement of the new machine was made by R. G. Hennessey, General Manager of the firm's Industrial Products Division, author of "8mm Magnetic Sound Film in Audio-Visual Applications," presented at the SMPTE 89th Convention in Toronto. The new machine, designed as a portable sales aid and for educational purposes, provides a synchronous sound motion-picture presentation from 8mm magnetic film. The picture is projected in an integral 11 by 8¼-in. screen and can play continuously without reload or rewind from a 200-ft capacity magazine. The complete unit is contained in a package resembling a portable typewriter. Dimensions, closed, are 12 by 12 by 8¼in.; opened, 12 by 12 by 18¼ in. It will be priced in the neighborhood of $400. A companion model with a 400-ft capacity, weighing approximately 17 lb, will also be available.



The Wireless Remote Telesonic Projector introduced by Bell & Howell, 7100 McCormick Rd., Chicago 45, is an 8mm projector for home use that can be remotely controlled from start to finish of the movie, including turning on and off the room lamp. High-frequency sound waves inaudible to the human ear are emitted from the hand-held control unit and are picked up by a receiver built into the projector which triggers the various operations. The unit has two buttons, one to start, reverse and shut off the projector, and the other to freeze the action on the screen. Projection speed can be varied from 16







LOAFER

This Photo-Sonics 16mm-1B high-speed camera has just run 400 feet of film in 27 seconds. That's 600 clear, sharp frames per second. Even at that, it's only loafing. A unique combination of optical prism and variable disc shutter gives an easy, continuous film movement. This permits speeds up to 1,000 frames per second with the picture quality of an intermittent camera that can attain less than one-half this speed.

The 115 volt AC model shown here gives smooth performance at 200, 400, 600, 800, and 1,000 frames per second, using only one motor. A low-speed gear box gives speeds of 14, 25, 50, 75, 100, 125, 150, and 250 frames per second—same motor. It's really a lot of cameras wrapped up in one convenient package.

Need more than 400 feet? The 1,200-foot magazine gives 48 seconds of recording time at 1,000 frames per second. 100-foot and 200-foot magazines, too.
Let us show you one of these loafers tomorrow. *It's the BEST high-speed camera in the world!*

Manufactured with precision by

PHOTO-SONICS, INC.
820 South Mariposa, Burbank, California

Distributed exclusively throughout the United States by

TRAID CORPORATION
17136 Ventura Boulevard, Encino, California

to 24 frames/sec and a micrometer framer allows precise framing of the picture on the screen. The projector with control unit is priced at about $299.95.

A Kerr Cell Instrumentation Camera System, Model KSC-51/A, which incorporates a trigger pulse generator in the control unit circuitry, has been announced by Electro-Optical Instruments, Inc., 2612 E. Foothill Blvd., Pasadena, Calif. An earlier model, KS-51, used an external pulse generator to initiate the shuttering action. The pulse generator of the new model permits operation from an external low voltage trigger source, as well as from an internal 60-cycle source. It has three output pulses: a 50-v pulse from a high-impedance source which can be utilized to provide time-base generation; a fixed 300-v pulse which provides Kerr-cell triggering action into a 50-ohm load; and a 100- to 300-v variable output pulse which is available for initiating other phenomena or instrumentation.

For many applications the generator can be used to initiate shuttering action directly without the use of higher voltage trigger pulses. The 300-v trigger is said to keep triggering delay times below 100 nanoseconds, while the jitter in the Kerr-cell shuttering action is no more than 15 nanoseconds. Possible applications include plasma and shock tube studies, and hypervelocity and impact phenomena research.

The TG-100 pulse generator may be added to the system as an accessory for applications where extreme time resolution is required.

The Stereoflex, a camera developed for a Navy project to take high-speed photographs in 3-D, has been announced by Benson-Lehner Corp., 1860 Franklin St., Santa Monica, Calif., as ready for production. The camera is designed to permit slowing down of explosive action and viewing it in 3-D. Special 35mm film is used, and the camera is said to be capable of accelerating from a standing start to a film speed of 127 mi/hr in less than one second, and thereafter to hold a steady, synchronous speed. It may be used as a rotary prism camera with or without stereo.

Newly designed ionization gauges produced by Westinghouse Electronic Tube Division for the National Aeronautics and Space Administration's Goddard Space Flight Center are "intended to sniff the thin atmospheres of near space and measure their density," according to a recent announcement. Because of a wide range of sensitivity (1×10^{-4} to 1×10^{-10} mm of mercury) the gauges are expected to be useful in gathering data at altitudes of from 70 to 450 miles where prevailing molecular densities range from 5×10^{14} molecules/cu in. to 5×10^{7} molecules/cu in. Designed as self-contained variants of the Bayard-Alpert ionization gauge, the gauges are triodes whose elements are a tungsten filament drawing 1.5 amp at 4 v; an ion collector working at −30 v, and a grid working at 150 v. These elements are mounted in a glass envelope 3½ in. long and 1 in. in diameter into which the atmosphere can be admitted by "unstoppering" the open end of the envelope.

In use, electrons from the hot cathode are accelerated across the 150-v potential difference between cathode and grid, acquiring sufficient energy to ionize gas molecules that have entered through the open port into the area of electron bombardment. A silvered ring-like ion trap just inside the port attracts ionized particles and neutralizes their charges to prevent spurious indications that would otherwise be caused by their entry. Because of their positive charge, ions produced through electronic-molecular collision are propelled to the negatively charged ion collector and produce a direct current in the ion-collector circuit. Since the ratio of this current to the grid current is proportional to the number of electronic-molecular collisions, and to the number of gas molecules within the envelope at any moment, the ratio serves as a base quantity which is transmitted to Earth to indicate the molecular density at that point in Space.

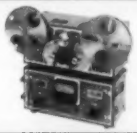
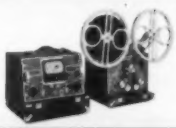
A new series of RF sweep and signal generators capable of providing up to 4 w of power has been announced by Telonic Industries, Inc., Beech Grove, Ind. Six models, designated PD-1 through PD-6, are included in the series covering the RF range from 5 to 1000 mc. A switch arrangement on each instrument enables the selection of one of four different modes of operation. The PD models employ high-power tubes to produce an output of 14 v rms into 50 ohms. The new instruments also include the Birdy-By-Pass Marker system by which beat frequencies may be added to the test signal. An external of 0.1 v may be added to the basic instrument accessories.

The Dynamax Power Pack, announced by Gordon Enterprises, 5362 N. Cahuenga Blvd., North Hollywood, is a nickel-cadmium battery with about six- to ten-hour capacity that can be repeatedly recharged. It is available with 12- and 24-v outputs for use with Hulcher and other cameras with similar power requirements. A dual Power Pack for use with arriflex cameras supplies either 8.5 v or 17 v, switch selected. A companion unit is the Dynamax Charger, operating on 115-v, a-c, used for overnight charging of the Power Pack.

The ColorTran Explosion-Proof Light, LCKS/64WP, designed for use in hazardous environments with PAR 64 lamps, has been announced by Natural Lighting Corp., 630 South Flower St., Burbank,

*How to select a recorder to start your MAGNASYNC-MAGNAPHONIC SOUND SYSTEM

Sound Equipment Checklist

		SPLIT 16 MM FILM	16 MM FILM	17½ MM FILM	35 MM FILM	REWIND	FOOTAGE COUNTER	POWER AMPLIFIER	MONITOR SPEAKER	TORQUE MOTORS	PLUG-IN AUDIO	PUSH BUTTON CONTROL	REMOTE CONTROL	SLIDE-WIRE POTS	FILM MONITOR	SYNKINETIC MOTION	PLUG-IN HEADS
Nomad MARK 1	 A versatile 7-lb. professional quality recorder/reproducer all transistorized and positively sprocket-hole interlocked with your 16mm camera or projector . . . CANNOT GET OUT OF SYNC! Can be hand held or tripod mounted. Wide selection of accessories available. Basic System $675.	X												X	X	
Nomad MARK 11	 The 12-lb. featherweight Mark 11, a professional double-system recorder/reproducer is completely transistorized, self-contained, and highly reliable with maximum recording qualities and operating economy. Power consumption is only 20 watts. From $985.	X													X	X	
X-400	 When lightweight portability is a **must** the 27 lb. X-400 Type 1 is the answer! Another reason so many producers choose this machine is that it is genuinely professional, and yet, surprisingly economical! From $985.		X			X	OPTIONAL	OPTIONAL	OPTIONAL						X	X	OPTIONAL
TYPE 1	 The Type 1 is a miniaturized version of the Type 5. Low power consumption and extreme portability has made this 39 lb. unit a popular selection for remote location production by leading professional motion picture studios. From $1430.		X	X		X	X	X	OPTIONAL		X				X	X	OPTIONAL
TYPE 15	 The X-400 Type 15 is designed for the man who wants everything in one case . . . playback amplifier, monitor speaker, footage counter and torque motors. You can be proud to have this machine represent you on any sound stage! From $1385.		X			X	X	X	X	X					X	X	OPTIONAL
TYPE 5	 The most popular magnetic film recorder in the world is the Type 5! With this unit and all its operational conveniences, you are definitely in the "major league." The Type 5 owner always starts his pictures with a special feeling of confidence in the realization that he has allowed no compromise in the selection of equipment. From $1650.		X	X	X	X	X	X	X	X	X				X	X	OPTIONAL
MARK 1X	 There is nothing on the market that compares with the remarkable Mark 1X. This unit is in a class by itself . . . with push-button remote controlled relay functions, plug-in audio elements and all the "extras" that make for flawless recording under the most adverse conditions. From $2145.		X	X	X	X	X	X	OPTIONAL	X	X	X	X	OPTIONAL	X	X	X

**Regardless of the model you select, you can always depend upon equipment with the "Magnasync-Magnaphonic" label . . . equipment made by the international leaders in the design and manufacture of quality magnetic film recording systems.*

MAGNASYNC Magnaphonic SOUND SYSTEM

Write, wire or phone

MAGNASYNC
CORPORATION

5546 Satsuma Avenue, North Hollywood, California
TRiangle 7-0965 • Cable "MAGNASYNC"

Magnasync Studio Equipment Division Dealers:

CHICAGO: Zenith Cinema Service, Inc.; Behrend Cine Corp.; **LOS ANGELES:** Birns & Sawyer Cine Equipment; **NEW YORK:** Camera Equipment Co.; Pictronics Corp.; **SAN FRANCISCO:** Brooks Camera; **SOUTH AFRICA:** Johannesburg, Photo Agencies Pty. Ltd.; **AUSTRALIA:** Sydney, New South Wales, Sixteen Millimetre Australia Pty. Ltd.; **BOLIVIA:** La Paz, Casa Kavlin; **BRAZIL:** Rio De Janeiro, Mesbla, S.A.; **BURMA:** Rangoon, G. K. Theatre Supply Co., Ltd.; **CANADA:** Toronto, Ontario, Alex L. Clark, Ltd.; **DENMARK:** Copenhagen, Kinovox Electric Corp.; **ENGLAND:** London, W-1, Delane Lea Processes, Ltd.; **FRANCE:** Paris, Brockliss-Simplex S.A.; **GERMANY:** Hilden, Dusseldorf, Gerhard Johansen; **GREECE:** Athens, Christos Axarlis; **HONGKONG:** Supreme Trading Co.; **INDIA:** Bombay, Kine Engineers; **ITALY:** Rome, Reportfilm, di J. M. Schuller; **JAPAN:** Tokyo, J. Osawa & Co., Ltd.; **NEW ZEALAND:** Auckland, Kerridge Odeon Industries; **PAKISTAN:** Karachi 3, Film Factors Ltd.; **SOUTH RHODESIA:** Salisbury, William Over & Co. Pvt. Ltd.; **THAILAND:** Bangkok, G. Simon Radio Co., Ltd.

Calif. The light is 10-in. in diameter and weighs 12 lb. It is said to provide usable photographic light equal to a 5000-w conventional studio key light when controlled by the ColorTran Converter. It is priced at $120.

The 40-amp Mark II Cinemaster Converter, designed to control eight 500-w PAR 64 lamps at 3400 K, has been announced by Natural Lighting Corp., 630 South Flower St., Burbank, Calif. The converter features two banks of color-coded pushbutton switches, each bank individually monitored on a Kelvin meter. A safety interlock switching is used to permit starting operation at normal lamp voltage only. The unit measures 9 by 9½ by 12 in. and weighs 50 lb. It is priced at $258. It is available with remote control on special order.

The Model 150 Milliampere Circuit Breaker, a product of Orbitec Corp., 512 30th St., Newport Beach, Calif., is a compact unit designed to protect transistor circuits against sudden or transient overloads. The circuit breaker is said to respond to 1-μsec transients, opening the load within 10 μsec. The trip current may be adjusted by a panel-front knob to any value between 15 and 150 ma. A "reset" button is depressed to close the circuit, but the instrument cannot be reset if an overload condition continues to exist. Accuracy is said to be ± 10%. Power may be supplied from any standard 120-v, 60-cycle source. It is priced at $160.

Books, Booklets, Brochures

Information Retrieval and Machine Translation (in two parts), edited by Allen Kent, is Volume 3 in the series, "Advances in Documentation and Library Science," General Editor, Jesse H. Shera. Published by Interscience Publishers, Inc., 250 Fifth Ave., New York 1, Part 1, is presently available at a price of $23. Part 2 is in press and is expected to be priced at about $25. The emphasis in Part 1 is on machine literature searching while Part 2 deals primarily with the problems of machine translation and the search for a common machine language. The two-part work represents the distillation of the research of seventy-five experts in the field of machine searching and translation of scientific literature, from ten countries. Included in Part 1 are many useful tables with detailed data on literature searching devices, analysis of literature, literature analysis-machine translation, language pairs under investigation, subject-fields covered, and translating equipment.

A translation of the Akusticheskii Zhurnal (Acoustics) of the USSR Academy of Sciences is offered by the American Institute of Physics in cooperation with the National Science Foundation. Presently available or scheduled are Vol. 6, Nos. 1–4 (containing material published in the original Russian Journal in 1960) and Vol. 7, Nos. 1–4 (containing material from the original Russian Journal in 1961). Subscription rate for each volume is $12.00 in the United States and Canada, and $14.00 elsewhere. A brochure containing a description of the periodical and selected titles from the Table of Contents is available without charge from American Institute of Physics, 335 E. 45 St., New York 17.

IEC Publication 124: *Recommendations for the Rated Impedances and Dimensions of Loudspeakers*, published by the International Electrotechnical Commission (IEC), is available from the American Standards Association, Dept. PR 198, 10 E. 40 St., New York 16. It is priced at $1.20. The IEC is the coordinating body for international standards in the fields of electricity and electronics. The publication applies to single moving-coil (dynamic) loudspeakers of the direct radiator type. It provides a series of rated impedances of the moving coil and mounting dimensions (size and arrangement of mounting holes). The dimensional recommendations are limited to loudspeakers having cones of circular section.

The Engineering Index for 1960 is now being compiled. Information, including the current catalog is available without charge from The Engineering Index, 29 W. 39 St., New York 18. For the 1959 Index, a staff of engineering linguists reviewed each issue of more than 1800 Engineering and Technological publications and selected therefrom and annotated more than 34,000 articles covering 249 fields of engineering. Publications from 44 countries in more than 20 languages are reviewed. Each annotation is supplied on a 3 × 5 library card. If a desired article is readily available, the Engineering Index undertakes to supply a photostat or microfilm copy of the entire article.

The first issue of Applied Optics, a bimonthly publication to be published by the Optical Society of America, 1155 Sixteenth St., N.W., Washington 6, D.C., is scheduled for January 1962. The magazine will be devoted to work in the areas of applied optics and closely related scientific and technical fields, such as physical, electron, ion, ultraviolet and space optics; lens design and optical formulas; plasma solid state and crystal physics. Each issue is planned to contain a leader review paper of about 10,000 words on one of the major aspects of optics or its applications, about 10 contributed technical papers of about 3000 to 5000 words, and other departments such as Letters to the Editor, Book Reviews, etc. The pre-publication annual subscription rate for OSA members is $6.00 and for nonmembers, $10.

An 8-page illustrated brochure describing in detail the RT-3A Heterodyne Repeater is available without charge from Adler Electronics, Inc., One LeFevre Lane, New Rochelle, N.Y. (att Mr. E. Strunin). The unit is designed for unattended TV and communications relaying in the 2-kmc frequency range.

employment service

These notices are published for the service of the membership and the field. They are inserted three months, at no charge to the member. The Society's address cannot be used for replies.

Positions Wanted

Motion-Picture Editor and Cameraman Presently with a multicam film project at Univ. of Ill. as Head Editor and Head Cameraman. Formerly with N.O.T.S. China Lake as Cameraman and Editor. B.A. and part M.A. from Univ. of Southern Calif., Dept. of Cinema. Also experienced in teaching basic cinema, motion-picture laboratory, still work, and other aspects of film production. Interested in a challenging position with potential. Write for resume or Form 57; Stanley Follis, 908 W. Maple St., Champaign, Ill.

Supervisory Photographic Technologist. Excellent instrumentation background obtained at four leading ordnance and missile Test Centers. Wide knowledge of cameras, lenses, mounts; including metric, engineering sequential, and documentary types. Broad film background. Supr. photo lab for 4 yrs. Purchasing and quality control background. Complete résumé upon request. Will relocate. Robert J. Millikin, 148 St. George Rd, Melbourne, Fla. PA 3-7819.

Cameraman/Producer. Extensive cine and still experience in training, public relations and industrial fields. Also experienced in cutting and sound recording. High-quality, low-budget script-to-screen producer. Interested in photo-instrumentation. Electronic engineering background. Recently completed Arctic assignment. Seeking challenging position in photography enabling use of past experience. Willing to travel and relocate worldwide. J.C.K., 3351 Alma St., Apt. 328, Palo Alto, Calif. DAvenport 6-2737.

Sound Recording Technician. Over 5 yrs experience in all phases of sound recording. Thoroughly familiar with mixing and recording sound for motion pictures, editing magnetic tapes and producing tapes for TV and radio. Interested in a permanent position with future. Willing to relocate. Thomas J. Hammeral, 137 92nd St., Brooklyn 9, N.Y. SH 5-7172.

Positions Available

16mm Film Editor, permanent staff, experienced, possibility of some directing. Church related film unit, with studio in Nashville, Tenn. Productions include dramatic, documentary and panels. Write TRAFCO of The Methodist Church for application, c/o Duane Muir, 1525 McGavock St., Nashville 3, Tenn.

Engineer. Position for individual with degree in Industrial Engineering, Photography or related field. Experience with motion-picture laboratory or data-processing equipment essential. This position is located in Florida. If interested, please forward resume to W. F. Marquette, RCA Employment Office, Patrick AFB, Florida.

Aero-Space Technology. Positions with National Aeronautics and Space Administration, Washington or other installations, from $5335 to $21,000 a yr. For applications and information on positions in physical sciences, engineering and mathematics; life sciences and systems; or research & development administration; write to Board of U.S. Civil Service Examiners, NASA, at any of the following Centers: Ames Research Center, Mountain View, Calif.; Flight Research Center, P.O. Box 273, Edwards, Calif.; Goddard Space Flight Center, Greenbelt, Md.; Langley Research Center, Hampton, Va.; Lewis Research Center, Cleveland 35, Ohio; Marshall Space Flight Center, Huntsville, Ala.

Mechanical Engineer (Motion Picture Cameras). Must have Mech. Eng. degree. Prefer 3 yrs experience in design of professional motion-picture cameras for theatrical and instrumentation fields. Work involves design and manufacture of 16mm and 35mm professional double-system and single-system cameras as well as high-speed instrumentation cameras. Excellent opportunities. Submit detailed resume in triplicate to 126 Warren Rd., Park Ridge, N. J.

Sales Representative for well known motion-picture processing laboratory, N.Y.C. Experienced in laboratory processes, motion-picture production, sound recording and re-recording operations. Must be able to deal with professional cameramen, producers and directors in the advertising and educational fields. Salary open. Unusual opportunity for advancement. Outstanding company benefits. Send résumé in complete confidence, including salary desired, to: Hokar Corp., 110 West 40 St., New York, N.Y.

Assistant to Owner of Film Lab. Unusual opportunity for man who is expert in timing and printing 16mm color and black & white. Must also have basic knowledge of general business practices and be endowed with the ability to lead and supervise. Write to CINE-CRAFT, 8764 Beverly Blvd., West Hollywood 48, California.

Staff Director, for medium-sized production company located in Louisville, Kentucky. Must have credits for TV commercials, industrials and slidefilms. Basic requirement is a creative attitude. We offer unlimited opportunities, pay in accord with experience, and an expanding company with which to be associated. Although location work is to be expected, off hours are pleasantly spent in this friendly, midwestern community. All replies are held in confidence. Vogue Film Productions, Inc., Bowman Field, Louisville, Ky.

Motion-Picture Laboratory Engineer. Experienced in lab procedures, design and maintenance of motion-picture lab equipment. Knowledge of air conditioning, chemical piping and pumps desirable. Located New York City. Send resume giving experience and salary desired to Box 1979, 125 West 41 St., New York 36.

Journals Available/Wanted

These notices are published as a service to expedite disposal and acquisition of out-of-print Journals. Please write direct to the persons and addresses listed.

Available

Index 1936–1945; Mar.–Sept., Nov., Dec. 1947; Jan., Feb., Sept., Nov., Dec., Index Jan.–June 1948; Jan., Mar. & High-Speed Photography, Apr.-July, Index Jan.–June, Sept.–Dec., Index July–Dec. 1949; Jan.-Oct., Dec., Indexes Jan.–Dec. 1950; Jan.–Apr., June, July, Sept.–Dec., Indexes Jan.–Dec. 1951; Jan.–July, Index Jan.–

June 1952; Jan.–Aug., Nov., Dec., Indexes Jan.–Dec. 1953; Jan.–June, Aug.–Dec., Indexes Jan.–Dec. 1954; Jan.–Dec. & Index 1955; Jan.–Dec. & Index 1956; Jan., Mar. 1957; Jan., Apr. 1958. Available as entire lot for $100. Camille Buyse, 1232 Chaussee de Wavre, Auderghem-Brussels 16, Belgium.

Jan. 1936 through Mar. 1957, except Mar. 1942 and Jan. 1945. Send offer to: R. S. Parris, 29 Charles St., Natick, Mass.

Assortment of Journals, from 1937 through 1950. Write: Alan Cook, South Londonderry, Vt.

Complete set of Journals March 1937 through May 1954. Best offer. A. R. Ulmer, 69 Cresskill Ave., Dumont, N. J. DU 4-8656.

Complete set of Journals January 1949 through December 1960, inclusive, including high-speed, special issues, indexes, directories, etc., in excellent condition. For sale as entire lot only. Leslie Helhena, P. O. Box 643, Burbank, Calif.

Complete set of Journals from January 1934 through June 1960. Excellent condition. For sale only as a set. Write: Don Norwood, 1470 San Pasqual St., Pasadena, Calif.

Complete file, Vol. I No. 1 through Dec. 1959 with indexes. Fine condition: $500. James G. Barrick, 15726 Fernway Ave., N. W., Cleveland 11, Ohio.

Complete set of Transactions, except Nos. 6 and 9, and all Journals published to date, including indexes. All in good condition. Price $500. Also extra copies of Transactions Nos. 21, 31, 32. W. W. Hennessey, RFD #2, Pound Ridge, N. Y.

Complete set of Journals from May 1937 to June 1954, including special volumes and membership directories, excellent condition; also Mar., May 1934 and July 1935 issues. Write: Harry R. Lubcke, 2443 Creston Way, Hollywood 28, Calif. HO 9-3266.

Jan-Dec. 1950; Jan., Feb., Apr.-Dec. 1951; Jan-Mar. 1952. Also available are vols. 6 and 7 of The Television Society (British) covering the period Jan. 1950 through Sept. 1955. Write: Andrew N. McClellan, 65 Hillside Drive, Toronto 6, Ont., Canada.

Dec. 1946, Feb.-Dec. 1947, 1948–1955 complete. All copies in perfect condition; for sale as entire lot only. Write: Joseph W. MacDonald, 2414 Sullivant Ave., Columbus 4, Ohio.

Jan. 1947 to Dec. 1957 complete and in perfect condition. For sale only as a set. Write: Charles J. Marshall, 2816 Royalston Ave., Kettering 19, Ohio.

Complete set of Journals Jan. 1949 to Dec. 1958. Perfect condition. What offers? Write: J. G. Jackson, 210 Kingsway South, Port Alberni, B. C., Canada.

Wanted

Jan., July, Sept. and Nov. 1949; Jan and Feb. 1950. Century Lighting, Inc. (Mrs. Levine), 521 W. 43 St., New York 36, N.Y.

Feb., Mar., Apr., June 1934. Mrs. Janet Van Duyn, Librarian, CBS Laboratories, 227 High Ridge Rd., Stamford, Conn.

Journals—Bound volumes. Write: S. P. Solow, Consolidated Film Industries, Inc., 959 Seward St., Hollywood.

Transactions 6 and 9 ($15 each offered). W. W. Hennessey, RFD #2, Pound Ridge, N.Y.

Jan. 1938, Jan. 1949. (Many other issues are available for trade.) Dept. of Cinema, Univ. of Southern Calif., University Park, Los Angeles 7. Att: Herbert E. Farmer.

Transactions No. 1, 1916 ($5 offered); No. 6, 1918 ($10 offered); No. 7, 1918 ($10 offered). James G. Barrick, 15726 Fernway Ave., N.W., Cleveland 11, Ohio.

Mar. 1939, May 1940, July, Feb. 1942, July 1949. V. E. Patterson, 2 North 30th St., Phoenix, Ariz.

Résumés / Resumenes / Zusammenfassungen

Techniques de sonorisation, doublage et report audio mises en oeuvre dans les productions sur ruban-images

John D. Silva [419]

De nombreuses productions sur ruban-images pour la télévision nécessitent l'addition ultérieure de musique et d'effets sonores au dialogue initial. Diverses méthodes ont été employées pour obtenir ce résultat. Trois méthodes ont été utilisées avec succès à la Station KTLA. La méthode 3, mise au point par Ryder Sound Services, Inc., est conçue pour obtenir un contrôle maximum et est employée pour effectuer des opérations compliquées de mélange, de sonorisation et de doublage. Une variance de cette méthode, réalisée pour des conditions d'emploi moins rigoureuses, a pour but d'éviter la revision du film monté sur pignon. L'auteur discute aussi une méthode proposée qui est basée sur l'emploi d'un magnétophone multi-piste à ruban-audio de 2 pouces (50,8mm).

Système synchroniseur perfectionné utilisant un ruban magnétique

Loren L. Ryder [426]

Une nouvelle méthode a été inventée pour synchroniser les appareils de prise de vues et les appareils d'enregistrement sonore. L'équipement qui a été conçu et mis au point spécialement pour répondre aux exigences de ce nouveau système comprend des générateurs synchronisés pour caméras, des têtes synchroniseuses à échelons pour magnétophones à ruban de ¼ de pouce (6,4 mm) et des resynchroniseurs pour projection à double film sur ruban de ¼ de pouce (6,4 mm). Cette méthode est applicable à la photographie à film de 35mm, 16mm et 8mm. Sa grande adaptabilité suggère qu'on en étende l'emploi aux amateurs, ainsi qu'aux domaines de l'industrie et de l'enseignement.

Un projecteur á chassis nouveau pour l'usage á la maison et pour d'autres emplois

Walter Beyer [429]

L'article décrit un projecteur nouveau qui rend possible la projection d'un film entier contenu dans un seul magasin ou dans une seule cassette. Aucun chargement du film n'est nécessaire

On fait copier le film original d'abord sur la moitié de la largeur d'une bobine de film à 420 m environ, et puis, après avoir renversé le film, sur l'autre moitié dans le sens opposé Deux pistes magnétiques sont appliquées sur les bords du film. A la fin du défilement de la première moitié du film le projecteur se déconnecte. On tourne la cassette 180 degrés et la deuxième moitié peut être projetée. Pendant la projection de la deuxième moitié du film la première moitié s'enroule automatiquement. Le temps de projection peut s'étendre jusqu'à plus de deux heures.

Ce principe de la cassette et de l'application de deux rangées d'images sur une bande de film s'emploie aussi pour les films et pour la projection stéreoscopiques, et surtout pour les films instructifs.

Analyse du bruit dans l'orthicon à image

B. H. Vine [432]

L'auteur examine le problème posé pour réaliser un tube de caméra qui puisse fonctionner à des niveaux de flux lumineux inférieurs à ceux actuellement utilisés sans réduction du rapport entre signal et bruit. Il est démontré que tout accroissement de sensibilité photocathodique ou de transmission du réseau permet une réduction correspondante de la lumière nécessaire pour obtenir un rendement égal. D'autre part, l'introduction d'accroissements du rapport entre secondaire et émission du voyant ou de la première dynode, meme s'ils sont indéfiniment grands, ne peut que produire une réduction limitée de la lumière nécessaire pour un rendement égal.

Un système à rayons X à flash de cinquante millimicrosecondes pour la radiographie à grande vitesse

F. J. Grundhauser et W. P. Dyke [435]

L'émetteur dit de température-et-champ, de réalisation récente, est utile dans les applications qui nécessitent à la fois une forte résolution et une grande vitesse. La cathode a été appliquée à une série de nouveaux tubes à rayons X qui fonctionnent à des intensités et des voltages allant jusqu'à 2000 amp et 600 kw respectivement. Des tubes antérieurs, qui fonctionnent à une longueur de pulsation de 0,2 μsec, permettent d'obtenir des clichés radiographiques avec bonne résolution à travers une épaisseur maximum de 8 pouces d'aluminium en une seule prise.

Les auteurs donnent une extrapolation de ces techniques à une longueur de pulsation de 50 mμsec. La résolution et la densité de la pellicule sont suffisantes pour divers mécanismes à hyper-vitesse. L'article décrit le fonctionnement du tube et du système à rayons X.

Le tube Astracon et son application en photographie à grande vitesse

A. E. Anderson, G. W. Goetze et H. Kanter [440]

Dans le domaine de la photographie à grande vitesse et à ultra-grande vitesse, les appareils de prise de vues qui utilisent des tubes électroniques mono-étage convertisseurs d'images se sont avérés très utiles. Toutefois, ces appareils photographiques de type électronique avaient en général l'in-

convénient d'un faible rapport lumineux, ce qui obligeait à éclairer fortement l'objet à photographier. L'emploi d'un tube intensificateur d'images de type multi-étage, tel que le tube Astracon, remédie à cette difficulté.

On a réalisé un appareil de prise de vues à grande vitesse pour un "rapport lumineux maximum" qui utilise deux tubes Astracon. Il est possible, au moyen de cet appareil, d'enregistrer des processus isolés de photo-électrons sur pellicule photographique. Les auteurs décrivent le fonctionnement général de cet appareil comme application particulière du tube Astracon en photographie à grande et ultra-grande vitesse à des niveaux de lumière extrêmement bas.

Caméra multi-images à grande vitesse VFK-ÚVOJM

JAN HAMPL [443]

Une caméra multi-images, à grande vitesse et à double tambour, capable de photographier des machines électriques ou mécaniques aux fins d'analyse quantitative, produit 1304 images, chacune de 5mm x 8mm, sur une longueur de 1850 mm de film non-perforé de 35mm. Cette caméra peut enregistrer à une cadence de 8000 à 42.000 images par seconde, avec une ouverture relative de f/7 et une résolution de 80 lignes/mm. La synchronisation du mouvement des images avec celui du film est obtenue en faisant tourner un tambour intérieur portant des lentilles d'objectif secondaires à la vitesse appropriée pour faire déplacer l'image à la meme vitesse que le film sur le tambour extérieur.

Un nuevo tipo de proyector para proyecciones familiares y otras aplicaciones con chasis especial automático

WALTER BEYER [429]

El artículo describe a un nuevo tipo de proyector, recientemente desarrollado, que facilita la proyección de una película de largo metraje ne su totalidad, mediante el uso de un chasis único y especial. No es necesario enhebrar la película.

La película de metraje ha sido copiada en su extensión entera sobre un solo rolla de material de aproximadamente 420 metros de largo, en dos bandas de sentido opuesto. Dos bandas de sonido magnético están situadas en los bordos de la película. Una vez terminada la proyección de la primera mitad de la película que se halla en el chasis, el proyector se desconecta automáticamente. Luego se gira el chasis por un ángulo de 180° y la segunda mitad queda en condición de ser proyectada. Durante le proyección de la segunda mitad, la primera mitad de la película es rebobinada automáticamente. La duración total del programa puede llegar a dos horas ó más.

El principio de este chasis y la disposición de imágenes dobles sobre una sola banda de película se aprovecha también para la proyección estereoscópica, para la proyección simultánea de dos imágenes y, sobre todo, para películas educacionales. (*Tr. de Pablo Tabernero*)

Analisis del ruido en el tubo orticón de imagen

B. H. VINE [432]

El problema de diseñar un tubo orticón para cámeras de television, que puede operar a los niveles del fundente de luz más bajos que ellos corrientemente usados sin una reducción de la proporción de señal-ruido, se examina aquí. Se muestra que algun aumento de la sensibilidad fotocátodo o transmisión engrane admite una reducción correspondiente de la luz requerida para ejecución igual. Por otro parte, los aumentos do la razón de la emisión secondaria de la tarja e del dinodo primero, aun, si son indefinidamente abultados, pueden producir solamente una reducción limitada de la luz requerida para ejecución igual.

Un sistema de rayos-X de flash de cincuenta milimicrosegundos para la radiografía de gran rapidez

F. J. GRUNDHAUSER y W. P. DYKE [435]

El emitador de temperatura y campo, del desarrollo reciente, es útil en las aplicaciones que necesitan tanto á un tiempo una resolución fuerte y una gran rapidez. El cátodo ha sido aplicado á una serie de tubos nuevos de ravos-x que funcionan á las intensidades y los voltajes yendo hasta 2000 amperios y 600 kv respectivamente. Unos tubos más primitivos, que funcionan al largo de pulsación de 0,2 μsec., permiten la consecución de las radiografías con buena resolución á través del espesor maximo de 8 pulgadas de aluminio en un pulso único.

Los escritores dan una extrapolación de estas técnicas al largo de pulsación de 50 μsec. La resolución y la densidad de la película están suficiente para unos mecanismos diversos á un hiper-velocidad. El artículo describe el funcionamiento del tubo y del sistema de rayos-x.

El tubo Astricon y su aplicación en la fotografía de gran rapidez

A. E. ANDERSON,
G. W. GOETZE y H. KANTER [440]

En el dominio de la fotografía de gran rapidez y

Tecnicas de escritura audio, doblaje y transferencia usades en las producciones en cinta video

JOHN D. SILVA [419]

Unas producciones en cinta video necesitan la adición de música y sonidos al diálogo original despues del complemento de la obra. Para efectuar esta adición unos métodos varios han estado empleado. Al puesto KTLA se han usado tres métodos con resultados buenos. El método numero 3, descogido por el Ryder Sound Services, Inc., se diseña para obtenir el control maximo, y se usa para efectuar las operaciones intrincadas del mezclar, doblaje y la escritura audio. Una variación de este método, diseñado para conformar a unas demandas menos estrictas, se usa para evitar la redacción de película con cabillas [sprocketed film]. El autor discute, tambien, un método propuesto establecido en el uso de un cinta audio multi-canal que usan cinta de 2 pulgadas.

Un sistema de sincronización mejorado usando cinta magnetica

LOREN L. RYDER [426]

Se ha inventado recientemente un método neuvo para la sincronización de cámaras y registradores de sonido. El equipo que se ha trazado y descogido específicamente para conformar con los requerimientos de este sistema neuvo incluye: engendradores "sync" para cámaras; escalones de cabezas sincronizantes para registradores que usan cinta de ¼ pulgadas; y re-sincronizadores para la proyección de doble-película en cinta de ¼ pulgadas. Este método es aplicable igualmente en la fotografía de 35mm, 16mm y 8mm. Su adaptabilidad sugere la probabilidad de una extensión de su uso en el campo de la fotografía aficionada tanto como en la fotografía industrial y educadora.

de ultra gran rapidez, las cámaras que utilizan unos tubos electrónicos monoetapas para convertir las imagenes han resultado útil. No obstante, estas cámaras electrónicas tienen la desventaja de una ganancia de luz muy pequeña, de suerte que se necesita una brillantez alta de la imagen primaria. El uso de un tubo intensificador de multi-etapas, tal que el tubo Astricon, evita esta dificultad. Ya se ha construido una cámara de gran rapidez con "una ganacia última de luz," empleando dos tubos Astricon. Con esta cámera es posible de recordar unos eventos aislados fotoelectrónicos en película fotográfica. Los escritores discuten el funcionamiento general del aparato tanto como las aplicaciones especificas del tubo Astricon en la fotografía de gran rapidez y de ultra gran rapidez a los niveles de luz extremamente bajas.

VFK-ÚVOJM—Una cámara de multi-imagenes de gran rapidez

JAN HAMPL [443]

Una cámara de tambor doble de multi-imagenes y de gran rapidez, capaz de fotografiar maquinaria mécanica y eléctrica con un movimiento rápido para el análisis cuantitativo, toma 1304 fotogramas, cada una de 5 x 8mm, en película no perforado de 35mm de una largura de 1850mm. Esta cámara puede recordar a una tasa de 8.000 a 42.000 fotogramas/sec., con una razón de abertura de f/7, y una resolución de 80 lineas/mm. La sincronización del movimiento de la imagen con la película moviente se efectua por medio de un tambor rotando interior que lleva unos lentes objectivos secundarios a la velocidad necesaria para causar un movimiento de la imagen a la misma velocidad que esta de la película en el tambor exterior.

Tonaufnahme, Nachsynchronisierung und Übertragungstechnik für Video-Magnetband Produktionen

JOHN D. SILVA [419]

Viele Video-Magnetband Produktionen erfordern die nachträgliche Einfügung von Musik und Toneffekten zum herkömmlichen Dialog. Man hat hier verschiedene Methoden angewandt, um eine glatte Programmabwicklung zu erzielen. Drei dieser Methoden, welche bei dem Fernsehsender KTLA besonders erfolgreich waren, werden erläutert.

"Methode 3," entwickelt bei der Firma Ryder Sound Services, Inc., erlaubt eine maximale Kontrolle der oft sehr verwickelten (!) Mischung, gg. Tonaufnahme und Nachsynchronisierung. Abarten der besagten Methode, welche sich auf etwas geringere Ansprüche beziehen, werden dann angewandt, wenn man den Schnitt eines perforierten Filmes vermeiden will. Zusätzlich wird dann noch eine neuere (in Angriff genommene) Methode erörtert, welche sich auf die zweckmässige Benutzung eines 2-Zoll Magnettongerätes—ausgestattet mit mehreren Aufnahmeköpfen—bezieht. (*Üb. von Lucas G. Lawrence*)

Verbessertes Synchronisierungs-System arbeitet mit Magnetband

LOREN L. RYDER [426]

Zwecks Synchronisierung von Kameras und Tonbandgeräten ist eine neue Methode entwickelt worden. Die diesbezüglichen Geräteeinheiten, deren Konstruktiona usdrücklich auf die Anforderungen des neuen Systems hin zugeschnitten wurde, schliessen Synchron-Generatoren, gestaffelte Synchronisierungsköpfe für ¼-Zoll Bandgeräte, sowie Nachsynchronisierer für Doppel-Film (ebenfalls auf ¼-Zoll Band) ein. Das Verfahren lässt sich auf 35mm-, 16mm- und 8mm-Kinematographie anwenden. Bedingt durch diese ungewöhnliche Anpassungsfähigkeit dürfte sich die neue Methode eventuell auch dem Amateur, sowie den Industrie-und Schulfilmgruppen, darbieten. (*Üb. von Lucas G. Lawrence*)

Ein völlig neuartiger Kassetten-Projektor für Amateur-Vorführungen und andere Anwendungen

WALTER BEYER [429]

Der Artikel beschreibt einen neuentwickelten Projektor, der es ermöglicht, einen ganzen Spielfilm in einem Magazin bzw. einer einzigen Kassette vorzuführen. Es ist kein Filmeinlegen nötig.

Der ganze Spielfilm ist in voller Länge auf einer Rolle Film von etwa 420 mtr Länge auf- und abwärts kopiert. Zwei Magnettonstreifen sind für den Ton vorgesehen und befinden sich am Aussenrande des Filmes. Nach Ablauf der ersten Hälfte des Filmes in der Kassette schaltet sich der Projektor von selbst ab. Die Kassette wird dann um 180 Grad gedreht und die zweite Hälfte kann projiziert werden. Während der Projektion der zweiten Hälfte spult sich die erste Hälfte des Spielfilmes automatisch zurück. Die gesamte Spieldauer kann bis zu 2 Stunden und mehr betragen.

Dieses Kassetten-Prinzip und die Doppelbildanordnung auf einem Filmstreifen wird auch für Stereofilme, Doppelbildprojektion und vor allem für Unterrichtsfilme benutzt. (*Üb. von Walter Beyer*)

Geräuschbestimmung im Bildorthikon

B. H. VINE [432]

Hier wird die Frage der Konstruktion einer Aufnahmeröhre, die bei einem niedrigeren Lichtstrompegel arbeitet als es heute üblich ist ohne den Geräuschabstand zu erhöhen, untersucht. Es wird nachgewiesen, dass eine Steigerung der Photokathodenempfindlichkeit oder der Maschenübertragung eine entsprechende Minderung des Lichtes bei gleichbleibender Leistung ermöglicht. Andererseits aber ergibt eine Steigerung des Sekundäremissionsverhaltnisses der Auftreffplatte oder der ersten Prellelektrode, wenn sie noch so gross ist, nur eine begrenzte Minderung des erforderlichen Lichtes bei gleichbleibender Leistung.

Eine 50 Millimikrosekunden Blitz-Röntgenanlage für Hochgeschwindigkeits-Röntgenbilder

F. J. GRUNDHAUSER und W. P. DYKE [435]

Der kürzlich entwickelte Temperatur- und Feldaussender ist für solche Anwendungszwecke geeignet für die sowohl hohe Rasterfeinheit als hohe Geschwindigkeit erforderlich sind. Die Kathode wurde bei einer Gruppe neuer Röntgenröhren verwendet, die bei Strömen und Spannungen bis zu 2000 A bezw. 600 kW arbeiten. Frühere Röhren, die bei einer Impulslänge von 0,2 Mikrosekunden arbeiteten, ergeben Bilder guter Schärfe, durch bis zu 8 Zoll Aluminum in einer einzigen Aufnahme.

Es wird eine Extrapolierung dieser Methoden bis zu einer Impulslänge von 50 Millimikrosekunden gegeben. Schärfe and Filmdichte sind für eine ganze Anzahl von Höchstgeschwindigkeits-Mechanismen genügend. Es folgt eine Beschreibung der Röhre und der Röntgenanlage.

Die Astracon-Röhre und ihre Anwendung in der Hochgeschwindigkeitsphotographie

A. E. ANDERSON G. W. GOETZE und H. KANTER [440]

In der Hochgeschwindigkeits- und Höchstgeschwindigkeits- Photographie haben sich Kameras mit einstufigen elektronischen Bildwandlerröhren als sehr nützlich erwiesen. Diese elektronischen Kameras haben gewöhnlich den Nachteil geringer Lichtstärke, so dass eine intensive Beleuchtung des Objekts erforderlich ist. Durch den Gebrauch einer mehrstufigen Verstärkerröhre wie der Astracon lässt sich diese Schwierigkeit vermeiden.

Es wurde bereits eine Hochgeschwindigkeits-Kamera für "grösste Lichtstärke" gebaut, die zwei Astracon-Röhren anwendet. Mit dieser Kamera ist es möglich einzelne Photoelektron-Erscheinungen im photographischen Film festzuhalten. Der Artikel behandelt die allgemeine Leistung der Kamera als spezielle Anwendung der Astracon-Röhre in der Hoch- und Höchstgeschwindigkeits-Photographie bei einem ausserordentlich niedrigen Lichtpegel.

VFK-ÚVOJM Kamera mit schnellster Verschlussgeschwindigkeit

JAN HAMPL [443]

Eine Doppeltrommel-Kamera mit schnellster Verschlussgeschwindigkeit, mit welcher sich schnell bewegende mechanisch und elektrisch angetriebene Maschinen zwecks quantitativer Analyse photographiert werden können, erzielt 1304 5 x 8mm Aufnahmen auf einem 1850 mm langen 35 mm Filmstreifen. Die Kamera registriert 8000 bis 42.000 Bild/Sek. bei einem Öffnungsverhältnis von f/7 und einer Auflösung von 80 Linien/mm. Synchronisierung der Bildbewegung mit dem sich bewegenden Film wird erzielt, indem die mit Linsen eines Sekundärobjektivs versehene Innentrommel mit solch einer Geschwindigkeit rotiert wird, die dazu erforderlich ist um das Bild ebenso schnell wie den an der Aussentrommel befindlichen Film bewegen zu lassen.

Ed. Note: Since last January we are publishing in the *Journal* as a regular feature translations of the titles and abstracts of all papers in French, German and Spanish. This is intended to increase the *Journal's* usefulness to the Society's growing number of non-English Speaking members and Subscribers overseas. Comments of readers are invited. The Society is particularly anxious that the translrtions used should be of the best quality obtainafile, therefore comments on their quality and suggestions for their improvement would be especially welcome. Also, since the cost of buying all the translations from a commercsal translator is prohibitiee, any assistance that may be volunteered in obtaining translations for the *Journal* will constitute a very considerable contribution to the Society. Contributors will of course, be given full acknowledgment in the *Journal*.

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Meeting Calendar

AIEE, Summer General Meeting, June 18–23, Ithaca, N.Y.

American Rocket Society, Institute of the Aerospace Sciences, Joint Midyear Meeting, June 19–22, Los Angeles.

American Physical Society, Meeting, June 22–24, Univ. of Mexico, Mexico City, Mex.

IRE, National Convention on Military Electronics, June 26–28, Shoreham Hotel, Washington, D.C.

AIChE, AIEE, ASME, IRE, ISA, Joint Automatic Control Conference, June 28–30, Univ. of Colorado, Boulder, Colo.

British IRE, Annual Convention, July 5–9, Christ Church, Oxford, England.

USSR Ministry of Culture and Union of Cinematographers, 2nd International Film Festival, July 9–23, Moscow, USSR.

IFME, JECMB, IRE-PGBME, 4th International Conference on Medical Electronics and 14th Conference on Electronic Techniques in Medicine and Biology, July 16–21, Waldorf-Astoria Hotel, New York.

NAVA, Annual Convention, July 22–25, Hotel Morrison, Chicago.

American Rocket Society, Guidance and Control Conference, Aug. 7–9, Stanford Univ., Stanford, Calif.

SPIE, National Convention, Aug. 7–10, Ambassador Hotel, Los Angeles.

Western Electronic Show and Convention, Aug. 22–25, San Francisco.

American Chemical Society, 6th International Conference on Coordination Chemistry, Aug. 27–Sept. 1, Wayne State Univ., Detroit, Mich.

UFPA, Annual Meeting, August 1961, Berkeley Campus, U. of California.

American Chemical Society, National Meeting, Sept. 3–8, Chicago.

IRE, National Symposium on Space Electronics and Telemetry, Sept. 6–8, Albuquerque, N.M.

PGIT, International Symposium on Transmission and Processing of Information, Sept. 6–8, MIT, Cambridge, Mass.

AIEE, ISA, IRE, Joint Nuclear Instrumentation Symposium, Sept. 6–8, North Carolina State College, Raleigh, N.C.

ISA, Fall Instrument-Automation Conference and Exhibit, Sept. 11–15, Memorial Sports Arena, Los Angeles.

Electronic Industries Association, Annual Meeting, Sept. 12–14, New York.

Standards Engineers Society, Annual Meeting, Sept. 18–20, Hotel Sherman, Chicago.

IRE, AIEE, Industrial Elpctronics Symposium, Sept. 20–2d, Boston, Mass.

Illuminating Engineering Society, National Technical Conference, Sept. 24–29, Chase-Park Plaza Hotel, St. Louis, Mo.

Electrochemical Society, Fall Meeting, Oct. 1–5, Statler Hotel, Detroit, Mich.

IRE, Canadian Electronic Conference, Oct. 2–4, Automotive Bldg., Exhibition Park, Toronto, Ont.

90th Semiannual Convention of the SMPTE, Oct. 1–6, Lake Placid, N.Y.

National Electronics Conference, Oct. 9–11, International Amphitheatre, Chicago.

American Standards Association, National Conference, Oct. 10–12, Rice Hotel, Houston, Texas.

ASCE, Annual Meeting, Oct. 16–20, Hotel Statler, New York.

ASME, Annual Meeting, Nov. 26–Dec. 1, Hotel Statler, New York.

Society of Reproduction Engineers, Visual Communications Congress, Dec. 1–4, Hotel Biltmore, Los Angeles.

AICE, Annual Meeting, Dec. 3–6, New York.

91st Semiannual Convention of the SMPTE, Apr. 29–May 4, 1962, Ambassador Hotel, Los Angeles.

6th International Congress on High-Speed Photography, Sept. 17–22 1962, Hotel Kurhaus, Scheveningen, Netherlands.

92nd Semiannual Convention of the SMPTE, Oct. 21–26, 1962, Drake Hotel, Chicago.

93rd Semiannual Convention of the SMPTE, Apr. 21–26, 1963, Traymore Hotel, Atlantic City, N.J.

94th Semiannual Convention of the SMPTE, Oct. 13–18, 1963, Somerset Hotel, Boston.

SMPTE Officers and Committees: The rosters of the Officers of the Society, its Sections, Subsections and Chapters and of the Committee Chairmen and Members were published in the April 1961 Journal.

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TELIC, Incorporated
Titra Film Laboratories, Inc.
Traid Corporation
Trans-Canada Films Ltd.
Van Praag Productions
Westinghouse Electric Corporation
Westrex Corporation
Wilding Inc.
Wollensak Optical Company

The Society invites applications for Sustaining Membership from other interested companies. Information may be obtained from the Chairman of the Sustaining Membership Committee, Ethan M. Stifle, Eastman Kodak Co., Room 626, 342 Madison Ave., New York 17, N.Y.